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NOTE: MIL-STD-22 has been redesignated as a Design Criteria Standard. The cover page has been changed for Administrative reasons. There are no other changes to this Document.

MIL-STD-22D
25 MAY 1979
SUPERSEDING
MIL-STD-0022C (SH)
29 AUGUST 1977
SUPERCEDING
MIL-STD-0022B (SHIPS)
8 MAY 1969, and
MIL-STD-22A
24 OCTOBER 1956

DEPARTMENT OF DEFENSE
DESIGN CRITERIA

WELDED JOINT DESIGN

AMSC N/A FSC THJM

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NAVAL SEA SYSTEMS COMMAND

DEPARTMENT OF THE NAVY

WASHINGTON, DC 20362

Welded Joint Design
MIL-STD-22D

1. This Military Standard is approved for use by all Departments and agencies of the Department of Defense.

2. Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander, Naval Sea Systems Command, SEA 3112, Department of the Navy, Washington, DC 20362 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

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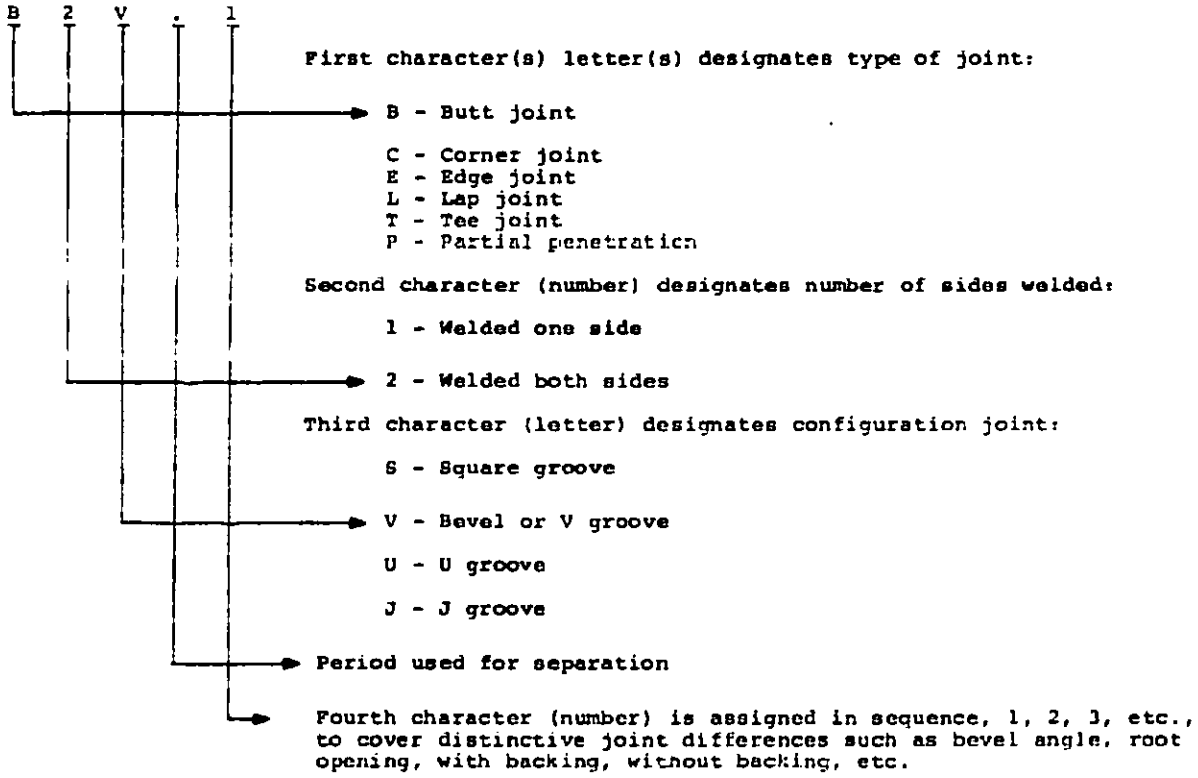
FOREWORD

This standard contains structural and piping system weld joint designs for ship construction. Joint designs shall be selected in accordance with the fabrication document which invokes this standard. The identification of the joint designs is as follows:

(A) Structural, machinery and pressure vessel joint numbering system (figures 1 through 32)

The structural, machinery and pressure vessel joint numbering system is composed of four character groups. By means of the four groups, a unique identification is assigned to each joint design. As an example:


B 2 V . 1
First character(s) letter(s) designates type of joint:
B - Butt joint
C - Corner joint
E - Edge joint
L - Lap joint
T - Tee joint
P - Partial penetration
Second character (number) designates number of sides welded:
1 - Welded one side
2 - Welded both sides
Third character (letter) designates configuration joint:
S - Square groove
V - Bevel or V groove
U - U groove
J - J groove
Period used for separation
Fourth character (number) is assigned in sequence, 1, 2, 3, etc., to cover distinctive joint differences such as bevel angle, root opening, with backing, without backing, etc.

(B) Piping system joint numbering system (figures 33 through 70)

Joints associated with piping portions of fluid systems are designated "P", followed by a number, such as P-6. Joints associated with pressure vessels of fluid systems are designated "V", followed by a number, such as V-6.

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CONTENTS

			Page
Paragraph	1.	SCOPE	1
	1.1	Scope	1
	2.	REFERENCED DOCUMENTS	1
	2.1	Issues of documents	1
	2.2	Other publications	1
	3.	GENERAL REQUIREMENTS	1
	4.	JOINT DESIGN SELECTION	3

FIGURES

Figure	1.	Permanent backing strap	4
	2.	Butt joints, square, B1S.1, B2S.1, B1S.2	5
	3.	Butt joints, welded on backing, B1V.1, B1V.2, B1V.3, B1V.5, B1V.6, B1V.7	6
	4.	Butt joints, single-V and single-bevel, B2V.1, B2(S)V.2	7
	5.	Butt joints, double-V and double-bevel, B2V.3, B2(S)V.4	8
	6.	Butt joints, single-U and single-J, B2U.1, B2U.2, B2U.3, B2J.1, B2J.2	9
	7.	Butt joints, double-U and double-J, B2U.4, B2U.5, B2J.3, B2J.4	10
	8.	Corner joints, open square, C1S.1, C2S.1	11
	9.	Corner joints, outside single-V, C1V.1, C2V.1	12
	10.	Corner joints, outside single-bevel, C1V.2, C1V.3	13
	11.	Corner joints, fillet-reinforced, outside single-bevel, C2V.2, C2V.3	14
	12.	Corner joints, fillet-reinforced, inside single-bevel, C1V.4, C2V.4	15
	13.	Corner joints, fillet welded, outside square, C1S.2, C2S.2	16
	14.	Corner joints, fillet-reinforced, double-bevel, C2V.5, C2V.6	17
	15.	Corner joints, single-U, C1U.1, C2U.1	18
	16.	Corner joints, welded one side, outside single-J, C1J.1, C1J.2, C1J.3, C1J.4	19
	17.	Corner joints, fillet-reinforced, welded both sides, outside single-J, C2J.1, C2J.2, C2J.3, C2J.4	20
	18.	Corner joints, welded one side, single-bevel, C1V.5, C1V.6, C1V.7, C1V.8, C1V.9, C1V.10, C1V.11, C1V.12	21
	19.	Corner joints, welded one side and both sides, inside single-J, C1J.5, C2J.5	22
	20.	Corner joint, fillet-reinforced, double-J, C2J.6	23
	21.	Tee joint, partial penetration, PT1S.1	24
	22.	Tee joints, partial penetration, PT2S.1, PT2S.2, PT2S.3	25
	23.	Tee joints, (high efficiency) fillet-reinforced, double-bevel, partial penetration, PT2J.1, PT2V.1	26
	24.	Tee joint, fillet-reinforced, double-bevel, partial penetration, PT2J.2, PT2V.2	27
	25.	Tee joint, fillet-reinforced, single-bevel, T1V.3, T2V.1	28
	26.	Tee joint, fillet-reinforced, T2V.2, T1V.1, T1V.2	29
	27.	Tee joint, fillet-reinforced, single-J, T1J.1, T2J.1	30
	28.	Tee joint, fillet-reinforced, double-J, T2J.2	31
	29.	Lap joint, double-fillet-welded, L2S.1	32
	30.	Lap joints, L1V.1, L1S.1, L1S.2, L1V.2	33
	31.	Edge joints, E1S.1, E1V.1, E1U.1, E1U.2	34
	32.	Butt-welding plates of unequal thickness	35
	33.	Butt joint, square, P-1	36
	34.	Butt joint, V-groove, P-2	37
	35.	Butt joint, welded on permanent backing ring, V-groove, P-3	38
	36.	Butt joint welded on permanent, integral backing ring, V-groove, P-4	39
	37.	Butt joint, welded on removable backing ring, V-groove, P-5	40

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Page

Figure 38. Butt joint, welded on permanent backing ring, U-groove, P-6. 41
39. Butt joint, welded on removable backing ring, U-groove, P-7. 42
40. Butt joint, welded on flared type backing ring, V-groove, P-8. 43
41. Butt joint, welded both sides, square, P-9. 44
42. Butt joint, welded both sides, V-groove, P-10 45
43. Butt joint, welded both sides, double V-groove, P-11. . 46
44. Butt joint, automatic welded one side, V-groove, P-12 . 47
45. Fillet welded, slip-on coupling, P-13 48
46. Socket, fillet welded, P-14 49
47. Socket flange, fillet-welded, P-15. 50
48. Welded slip-on flange, fillet-reinforced, single-bevel, P-16 51
49. Structural sleeve for piping penetration, fillet welded, P-17 52
50. Double-fillet-welded slip-on flange, P-42 53
51. Branch connection, internal fillet-welded, P-60 54
52. Branch connection, external fillet-welded, P-61 55
53. Branch connection, welded on one side, external fillet-reinforced, single-bevel, P-62 56
54. Branch connection, welded both sides, external fillet-reinforced, single-bevel, P-63 57
55. Branch connection, welded on removable backing ring, external fillet-reinforced, single-bevel, P-64 58
56. Branch connection, welded on removable backing ring, internal fillet-reinforced single-bevel, P-66. 59
57. Integrally reinforced branch connection, welded on one side, single-bevel, P-67 60
58. Integrally reinforced fitting, branch connection, welded on one side or both sides, single-bevel, P-68. 61
59. Branch connection with pilot, fillet-reinforced, single-bevel, P-70. 62
60. Branch connection with plug, fillet-reinforced, single-bevel, P-71. 63
61. Branch connection, without pilot, fillet-reinforced, single-bevel, P-72 64
62. Consumable insert butt joints, V-groove and U-groove, P-73 through P-77. 65
63. Backing rings for welded pipe joints. 67
64. Root connections, V-4, V-5 and V-6. 69
65. Nozzle joints, V-7 and V-8. 70
66. Nozzle joints, V-9, V-11 and V-12 71
67. Flange pads, V-14 and V-15. 72
68. Root connection, V-21 through V-26. 73
69. Outlet connection, fillet-reinforced single-J, V-27 . . 74
70. Structural tank nozzle to pipe, fillet welded, V-28 . . 75

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1. SCOPE

1.1 Scope. This standard covers welded joint designs for manual, semi-automatic, and automatic arc and gas welding processes for use on metals and weldments, as applicable, when invoked by a fabrication document such as NAVSEA 0900-LP-000-1000 or MIL-STD-278. The welded joint designs shown herein represent standard joint designs used in welded fabrication and are not intended to be all inclusive. Modifications to these welded joint designs, other than those permitted by this standard, may be used subject to the approval of the authorized agent (see 3.2).

2. REFERENCED DOCUMENTS

2.1 Issues of documents. The following documents, of the issue in effect on date of invitation for bids or request for proposal, form a part of this standard to the extent specified herein.

SPECIFICATION

MILITARY
MIL-I-23413 - Inserts, Welding, Coiled Filler Material, Solid Rings.

STANDARD

MILITARY
MIL-STD-278 - Fabrication Welding and Inspection; and Casting Inspection and Repair for Machinery, Piping and Pressure Vessels for Ships of the United States Navy.
MIL-STD-1628 - Fillet Weld Size, Strength, and Efficiency Determination.

PUBLICATIONS

NAVAL SEA SYSTEMS COMMAND (NAVSEA)
0900-LP-000-1000 - Fabrication, Welding, and Inspection of Ship Hulls.
0900-LP-006-9010 - Fabrication, Welding, and Inspection of HY-80 Submarine Hulls.
0900-LP-014-5010 - Fabrication, Welding, and Inspection of Noncombatant Ship Hulls.
0900-LP-003-8000 - Surface Inspection, Acceptance Standards for Metals.

(Copies of specifications, standards, drawings, and publications required by contractors in connection with specific acquisition functions should be obtained from the contracting activity or as directed by the contracting officer.)

2.2 Other publications. The following documents form a part of this standard to the extent specified herein. Unless otherwise indicated, the issue in effect on date of invitation for bids or request for proposal shall apply.

AMERICAN WELDING SOCIETY (AWS)
A2.0 - Standard Welding Symbols.
A3.0 - Definitions-Welding and Cutting.

(Application for copies should be addressed to the American Welding Society, 2501 Northwest 7th Street, Miami, FL 33125.)

(Technical society and technical association specifications and standards are generally available for reference from libraries. They are also distributed among technical groups and using Federal agencies.)

3. GENERAL REQUIREMENTS

3.1 Definitions of welding symbols and terms used herein shall conform to AWS A2.0 and AWS A3.0, respectively.

3.2 For the purposes of this standard, the authorized agent is a Government representative specifically authorized to approve equipment, material, or procedures. They are as follows:

(a) For Government shipyards: The delegated representative of the Shipyard Commander.
(b) For commercial shipyards: The delegated representative of the Supervisor of Shipbuilding, Conversion and Repair.

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(c) NAVSEA.
(d) The delegated representative of other cognizant Government agencies.

3.3 Joints shall be so located, to the maximum extent possible, that the entire weld groove is visible for the welder and that no obstructions impair the accessibility for welding.

3.4 On full penetration joints welded from both sides, the root of the first weld shall be back-gouged, chipped, or ground to sound metal prior to welding the second side; however, joints may be welded without such cleaning when qualified processes, or techniques (for example twin-arc, submerged arc, etc.) are employed.

3.5 Reinforcement of welds shall be as specified in NAVSEA 0900-LP-003-8000.

3.6 Except as specified in 3.7, size of reinforcing fillet, "S" on structural joints, shall be 1/4 T (where T is the thickness of the thinner member) but in no case less than 1/8 inch, or greater than 3/8 inch.

3.7 For partial penetration tee joints; the following criteria shall be used to determine the land dimension, groove depth and reinforcing fillet size required for the desired joint efficiency based on the longitudinal shear strength of the weld metal.

$$D = \frac{eT^1R}{2R^1} \qquad Z = T_B - 2B$$

When calculated value of "D" is not greater than 0.707 inch.

$$B = \frac{D}{1.414}$$ except that B less than 1/4 inch shall not be used.

When calculated value of "D" is greater than 0.707 inch.

$$B = \sqrt{D^2 - 0.25}$$

S = B (to next larger 1/16 inch) except that reinforcing fillet size should be not less than 1/4 inch nor greater than 1/2 inch.

Where: D = effective width or the weld in shear

e = required joint efficiency

T^1 = thickness of the weaker member (T_B or T)

R = Ultimate tensile strength of the weaker base metal

R^1 = shear strength of the weld metal

Z = land dimension (to the nearest 1/16 inch)

T_B = thickness of web member

B = base leg or depth of bevel

S = size of reinforcing fillet

T = thickness of passing member

3.8 For joints with "U" or "V" bevels, the centerline of the included angle may be shifted from the position shown on the joint designs herein, as follows:

Included bevel angle Degrees	Maximum bevel angle shift Degrees
Less than 30	+5
30 up to 60	±10
60 and greater	±20

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Bevel angle shifts are permitted, provided the specified minimum total included angle is maintained.

3.9 For material 1-1/2 inches thick and over, the joint bevel angles specified by this standard need only be maintained for a minimum thickness of 5/8 inch to provide accessibility for welding the root, after which the included angle may be reduced to 20 degrees minimum for the remainder of the material thickness.

3.10 The maximum allowable root opening of backing strap or ring type joints, where only the minimum dimension is specified, shall be 1/4 inch above the specified minimum.

3.11 Fillet weld sizes for structural joints shall be determined in accordance with MIL-STD-1628.

3.12 Fillet weld sizes for piping system joints are based on the nominal pipe wall thickness (T), and are indicated on the applicable joint designs.

3.13 The minimum throat for fillet joints with equal legs shall not be less than 0.7 times the specified size. The minimum throat for fillets with unequal legs shall not be less than 0.7 times the specified short leg.

4. JOINT DESIGN SELECTION

4.1 Joint design shall be selected in accordance with the applicable fabrication document (e.g., MIL-STD-278, NAVSEA 0900-LP-000-1000, NAVSEA 0900-LP-006-9010, NAVSEA 0900-LP-014-5010, etc.).

Custodians:
Navy - SH
Army - MR
Air Force - 11
Review activities:
Navy - YD
Army - ER, CR
User activities:
Navy - MC, OS

Preparing activity:
Navy - SH
(Project THJM-0082)

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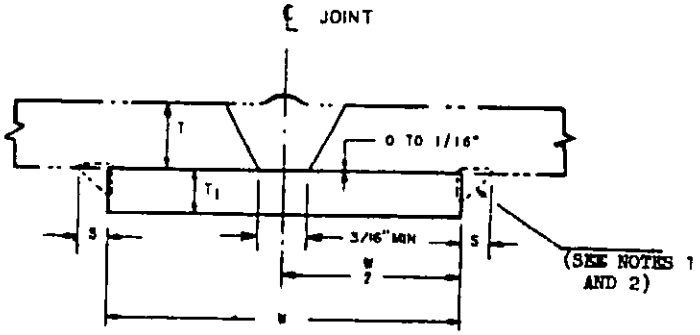

PERMANENT BACKING STRAP

SH1472B

Plate Thickness - (T) (inch)	T_1 min (inch)	W min (inch)
Up through 1/8	1/8	1/2
Over 1/8 through 5/16	3/16	1
Over 5/16	1/4	1-1/2

NOTES:
1. S = 1/2T, but in no case less than 1/8 inch or greater than 1/4 inch. The welds may be on either edge of the strap or within the weld groove.
2. Intermittent fillet welds or tack welds may be employed unless otherwise specified.
3. When shapes are used in lieu of backing strap, all above dimensions and notes shall apply.
4. Butt joints in permanent backing straps shall be welded, but need not comply with NDT requirements applicable to the welded joint itself.

FIGURE 1. Permanent backing strap.

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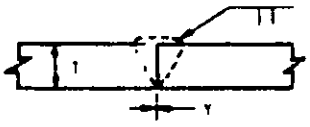
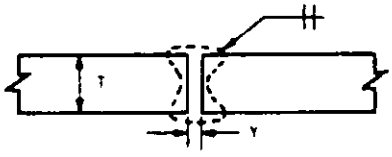
B1S.1 (SEE NOTE)



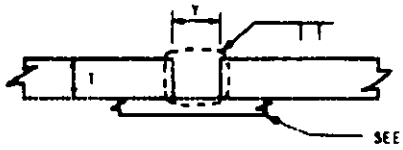
WELDED ONE SIDE

B2S.1



WELDED BOTH SIDES

B1S.2



WELDED ON BACKING

SH 1479

Joint number	Dim Y inch	Dim T inch, max
B1S.1	0 to 1/32	1/16
B2S.1	0 to T	1/4
B1S.2	T min	3/16

NOTE: Joints welded from one side without a backing, shall not be used when root of weld is subject to bending tension stress equivalent to one-half the yield strength of the base metal or greater.

FIGURE 2. Butt joints, square, B1S.1, B2S.1, B1S.2.

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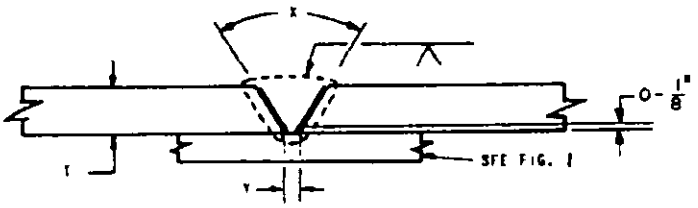
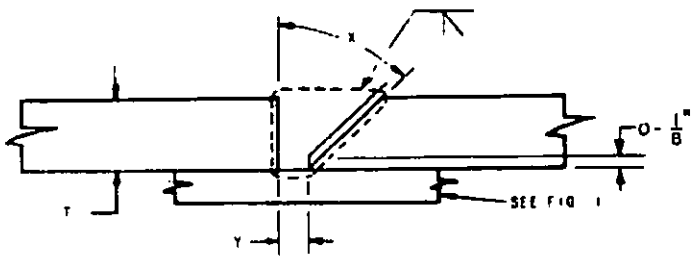
B1V.1
B1V.2
B1V.3



SINGLE-V

B1V.5
B1V.6
B1V.7



SINGLE BEVEL

SH14988

Joint number	Angle X min (degrees)	Dim Y min inch	Dim T inches	Welding position
B1V.1	45	3/16	Unlimited	All
B1V.2	35	1/4		All
B1V.3	20	3/8		Flat, vert, over
B1V.5	45	1/4		All
B1V.6	25	3/8		Flat, vert, over
B1V.7	35	3/8		All

FIGURE 3. Butt joints, welded on backing, B1V.1, B1V.2, B1V.3, B1V.5, B1V.6, B1V.7.

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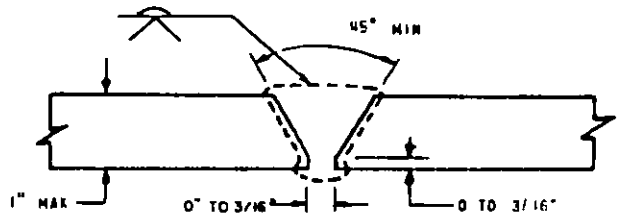
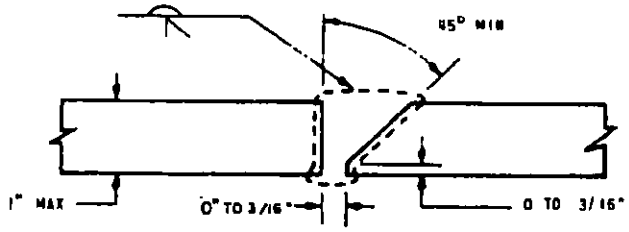
B2V.1



SINGLE-V

B2(S)V.2



SINGLE-BEVEL

SH1/R1B

FIGURE 4. Butt joints, single-V and single-bevel, B2V.1, B2(S)V.2.

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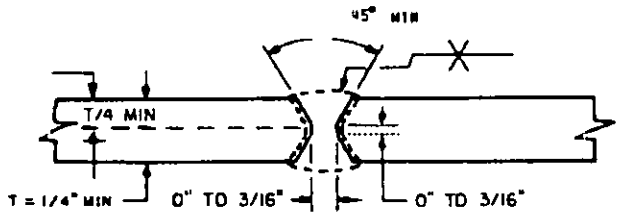
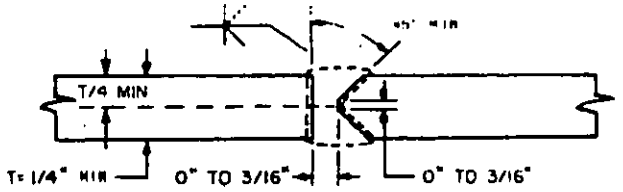
B2V.3



DOUBLE-V

B2(S)V.4



DOUBLE-BEVEL

SH1 A82B

FIGURE 5. Butt joints, double-V and double-bevel, B2V.3, B2(S)V.4.

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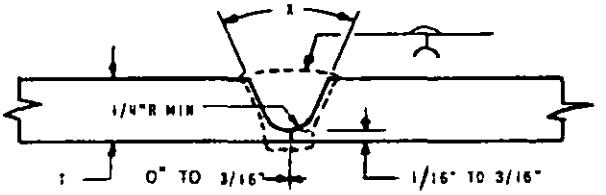
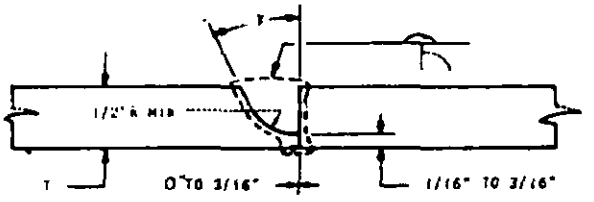
B2U.1
B2U.2
B2U.3



SINGLE-U

B2J.1
B2J.2



SINGLE-J

SH1L83B

Joint number	Angle X min (degrees)	Dim T (inch)	Welding position
B2U.1	35	3/4 min	All
B2U.2	20	3/4 min	Flat, vert, over
B2U.3	12	3/4 min	Flat
B2J.1	25	3/4 min	Flat, vert, over
B2J.2	35	3/4 min	All

FIGURE 6. Butt joints, single-U and single-J, B2U.1, B2U.2, B2U.3, B2J.1, B2J.2.

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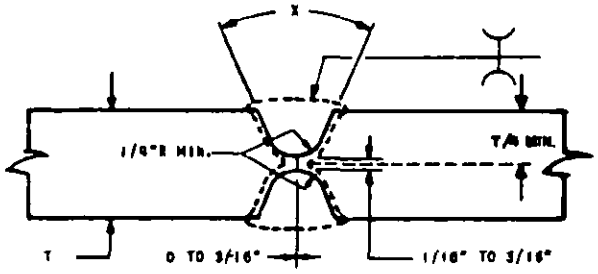
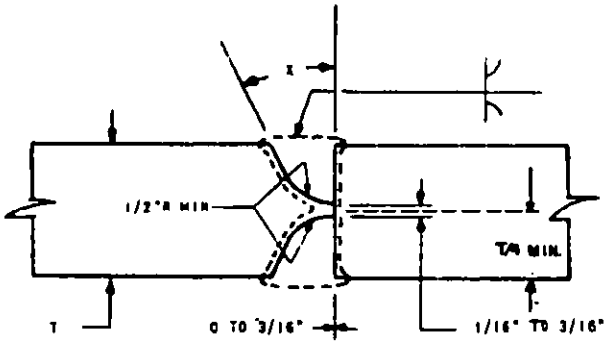
B2U.4
B2U.5



DOUBLE-U

B2J.3
B2J.4



SH902/A

DOUBLE-J

Joint number	Angle X min (degrees)	Dim T (inches)	Welding position
B2U.4	35	1-1/2 min	All
B2U.5	20	1-1/2 min	Flat,vert,over
B2J.3	25	1-1/2 min	Flat,vert,over
B2J.4	35	1-1/2 min	All

FIGURE 7. Butt joints, double-U and double-J, B2U.4, B2U.5, B2J.3, B2J.4.

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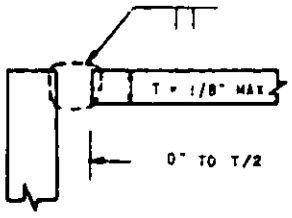
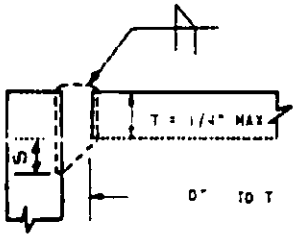
C1S.1 (SEE NOTE)



WELDED ONE SIDE

C2S.1



WELDED BOTH SIDES

SH9025A

NOTE: Joints welded from one side shall not be used when root of weld is subject to bending tension stress equivalent to one-half the yield strength of the base metal or greater.

FIGURE 8. Corner joints, open square, C1S.1, C2S.1.

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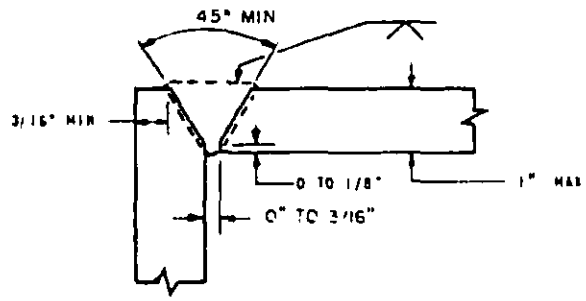
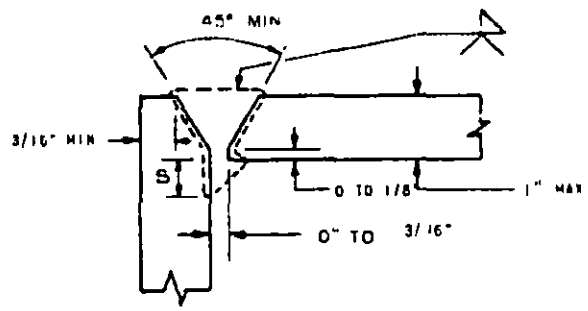
C1V.1 (SEE NOTE)



WELDED ONE SIDE

C2V.1



SH1485B

FILLET REINFORCED

NOTE: Joints welded from one side shall not be used when root of weld is subject to bending tension stress equivalent to one-half the yield strength of the base metal or greater.

FIGURE 9. Corner joints, outside single-V, C1V.1, C2V.1.

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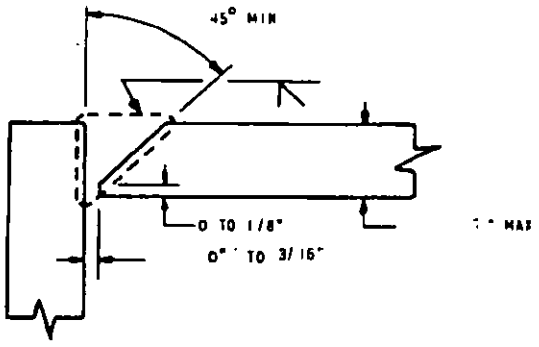
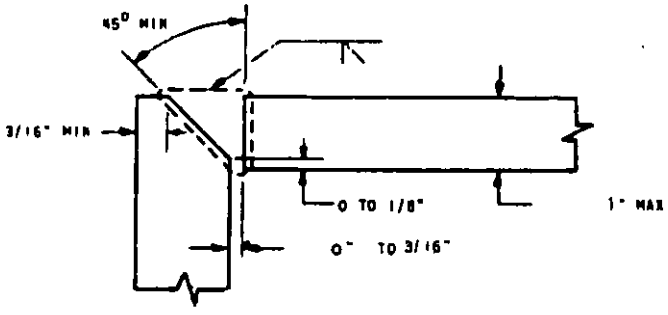
C1V.2 (SEE NOTE)



WELDED ONE SIDE

C1V.3 (SEE NOTE)



5H9020A

WELDED ONE SIDE

NOTE: Joints welded from one side shall not be used when root of weld is subject to bending tension stress equivalent to one-half the yield strength of the base metal or greater.

FIGURE 10. Corner joints, outside single-bevel, C1V.2, C1V.3.

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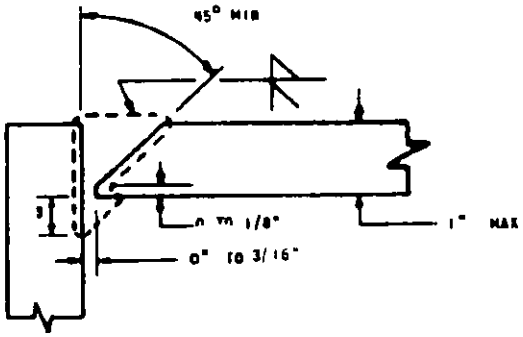
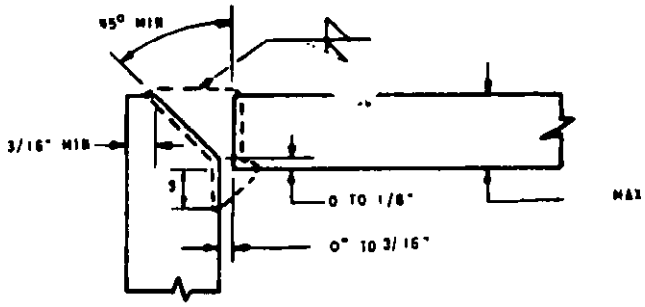
C8V.2



C2V 3



SH9027A

FIGURE 11. Corner joints, fillet-reinforced, outside single-bevel, C2V.2, C2V.3.

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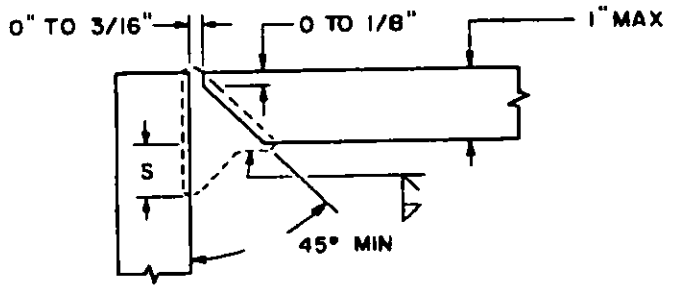
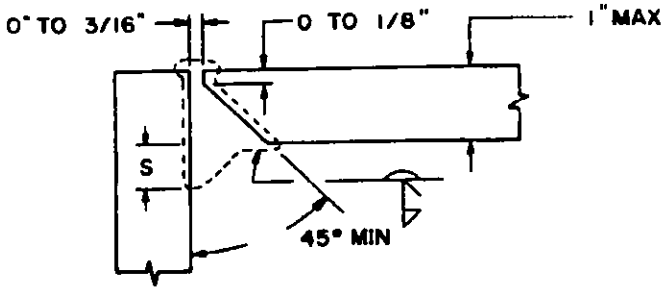
C1V.4 (SEE NOTE).



WELDED ONE SIDE

C2V.4



SH1486B

WELDED BOTH SIDES

NOTE: Joints welded from one side shall not be used when root of weld is subject to bending tension stress equivalent to one-half the yield strength of the base metal or greater.

FIGURE 12. Corner joints, fillet-reinforced, inside single-bevel, C1V.4, C2V.4.

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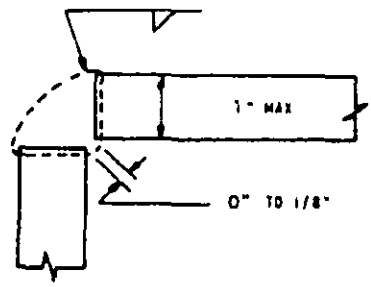
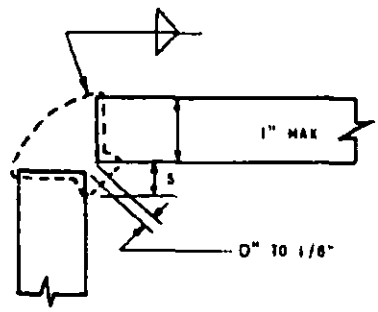
C1S.2 (SEE NOTE)



SINGLE.

C2S.2



DOUBLE.

SH1484B

NOTE: Joints welded from one side shall not be used when root or weld is subject to bending tension stress equivalent to one-half the yield strength of the base metal or greater.

FIGURE 13. Corner joints, fillet welded, outside square, C1S.2, C2S.2.

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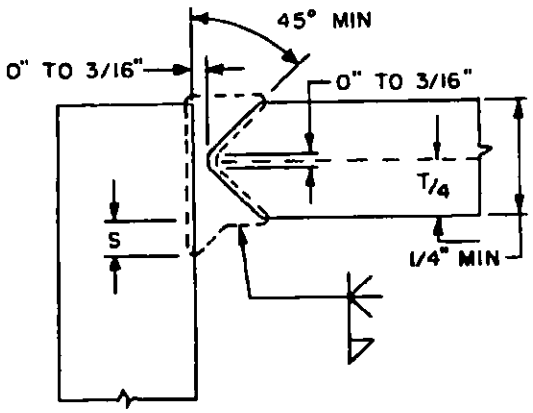
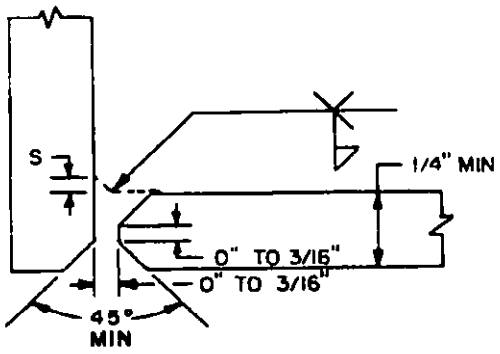
C2V.5



C2V.6



SH0028A

FIGURE 14. Corner joints, fillet-reinforced, double-bevel, C2V.5, C2V.6.

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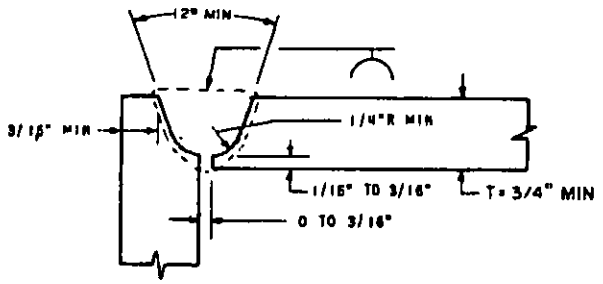
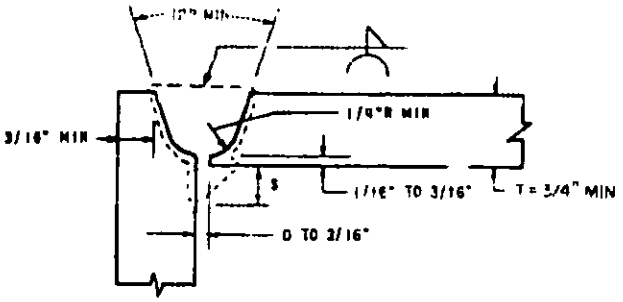
C1U.1 (SEE NOTE)



WELDED ONE SIDE

C2U.1



FILLET REINFORCED

ER1489B

NOTE: Joints welded from one side shall not be used when root of weld is subject to bending tension stress equivalent to one-half of the yield strength of the base metal or greater.

FIGURE 15. Corner joints, single-U, C1U.1, C2U.1.

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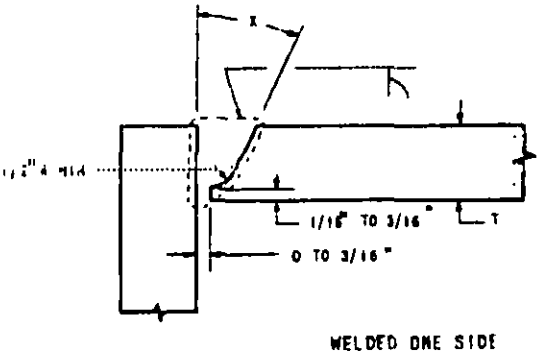
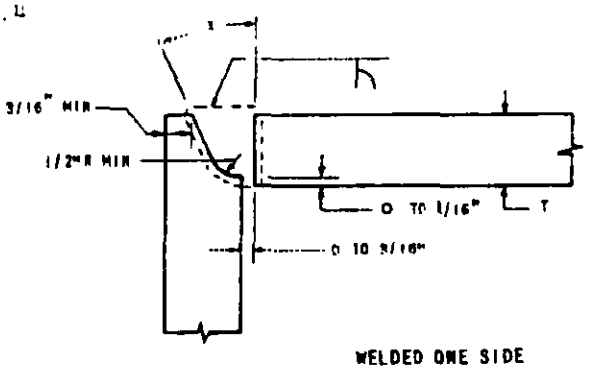
C1J.1 (SEE NOTE)
C1J.2



WELDED ONE SIDE

C1J.3 (SEE NOTE)
C1J.4



WELDED ONE SIDE

SH1488P

Joint number	Angle X min (degrees)	Dim T (inch)	Welding position
C1J.1, C1J.3	25	3/4 min	Flat,vert,over
C1J.2, C1J.4	35	3/4 min	All

NOTE: Joints welded from one side shall not be used when root of weld is subject to bending tension stress equivalent to one-half the yield strength of the base metal or greater.

FIGURE 16 Corner joints, welded one side, outside single-J, C1J.1, C1J.2, C1J.3, C1J.4.

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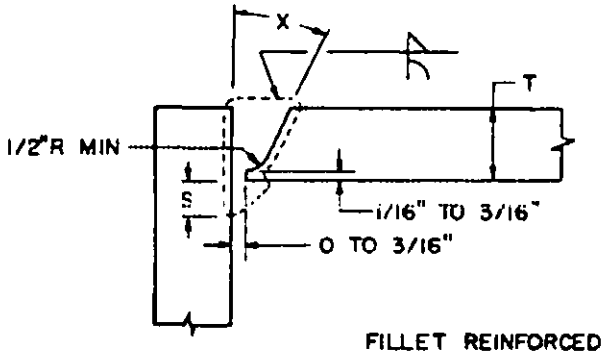
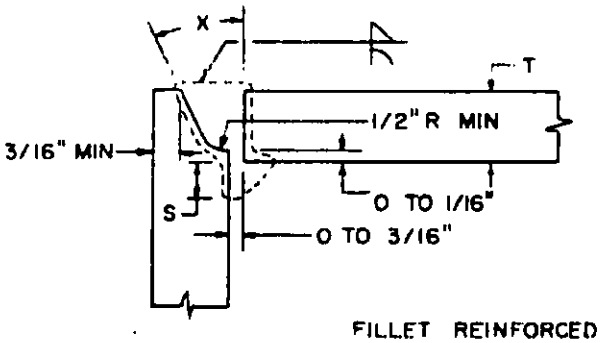
C2J.1
C2J.2



FILLET REINFORCED

C2J.3
C2J.4



FILLET REINFORCED

SH9J24A

Joint number	Angle X min (degrees)	Dim T (inch)	Welding position
C2J.1, C2J.3	25	3/4 min	Flat,vert,over
C2J.2, C2J.4	35	3/4 min	All

FIGURE 17. Corner joints, fillet-reinforced, welded both sides, outside single-J, C2J.1, C2J.2, C2J.3, C2J.4.

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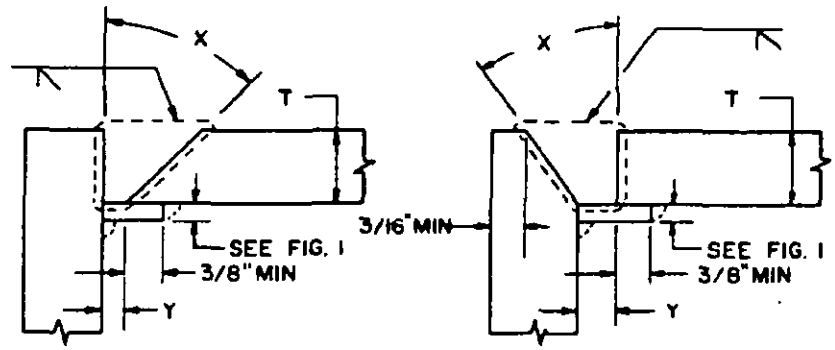
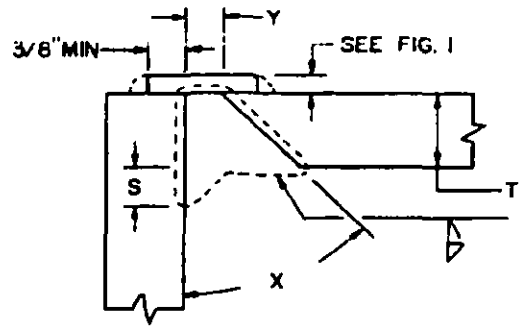
CIV.5
CIV.6
CIV.7

CIV.8
CIV.9
CIV.10



OUTSIDE-WELDED ON BACKING

CIV.11
CIV.12



INSIDE-WELDED ON BACKING
FILLET REINFORCED

GH1487b

Joint number	Angle X min (degrees)	Dim Y min (inch)	Welding position	Dim T (inch)
C1V.5,C1V.8, C1V.11	45	1/4	All	Unlimited
C1V.6,C1V.9, C1V.12	35	3/8	All	
C1V.7,C1V.10	25	3/8	Flat,vert and over	

NOTE: Backing may be removed and joint welded on both sides. If joint is not welded on both sides, the joint shall not be used when the root of the weld is subject to bending tension stress equivalent to one-half the yield strength of the base metal or greater.

FIGURE 18. Corner joints, welded one side, single-bevel, C1V.5, C1V.6, C1V.7, C1V.8, C1V.9, C1V.10, C1V.11, C1V.12.

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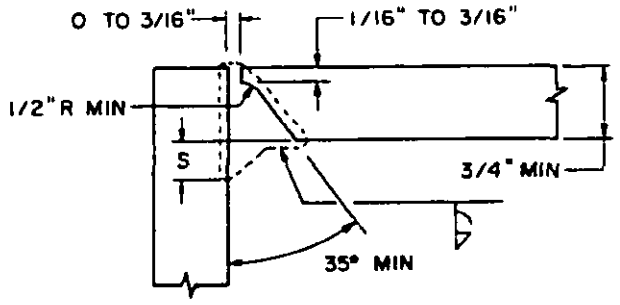
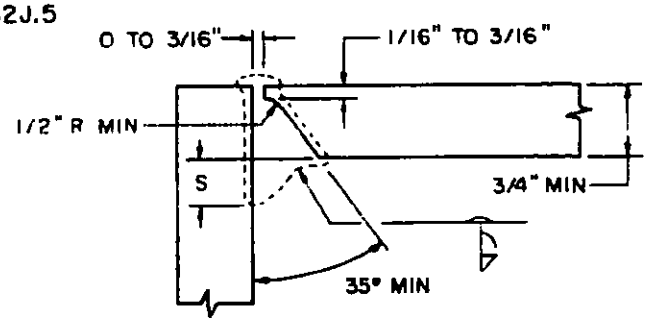
C1J.5 (SEE NOTE)



WELDED ONE SIDE

C2J.5



SH9030A

WELDED BOTH SIDES

NOTE: Joints welded from one side shall not be used when root of weld is subject to bending tension stress equivalent to one-half the yield strength of the base metal or greater.

FIGURE 19. Corner joints, welded one side and both sides, inside single-J, C1J.5, C2J.5.

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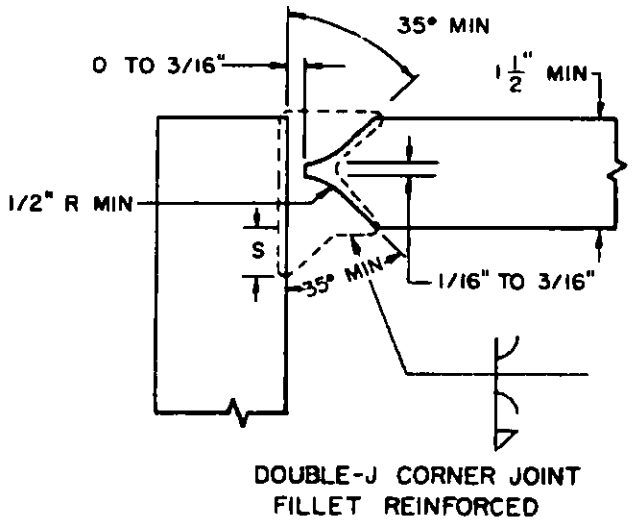
C2J.6



SH90031A

FIGURE 20. Corner joint, fillet-reinforced, double-J, C2J.6.

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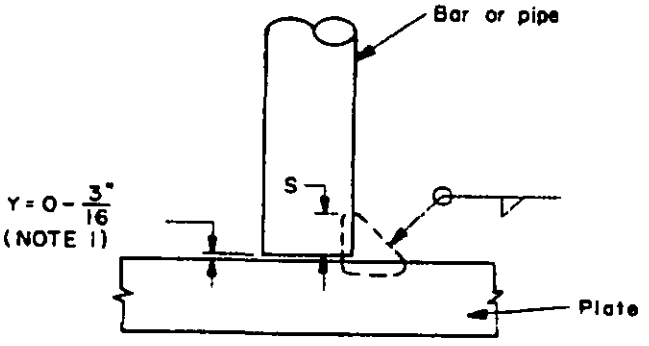
PT 1S-1



SH 11390

NOTE: Where Y is greater than 1/16 inch as a nominal condition, S shall be increased by an amount equal to the excess of the opening above 1/16 inch.

FIGURE 21. Tee joint, partial penetration, PT1S.1.

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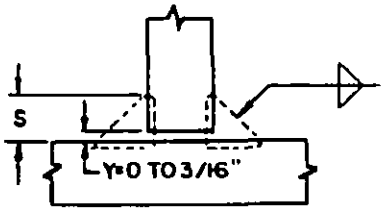
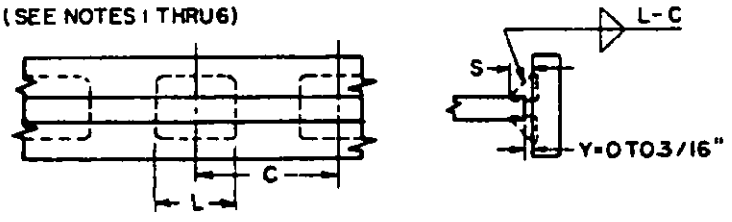
PT2S.1 (SEE NOTE. 1)



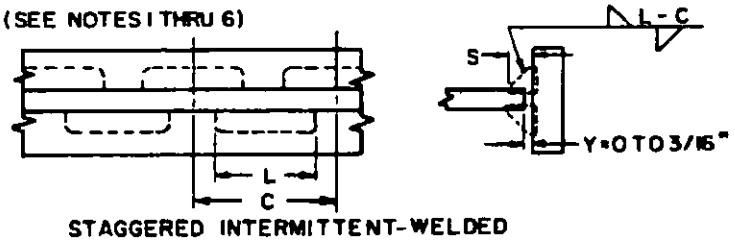
DOUBLE-FILLET-WELDED

PT2S.2 (SEE NOTES 1 THRU 6)



CHAIN INTERMITTENT-WELDED

PT2S.3 (SEE NOTES 1 THRU 6)



STAGGERED INTERMITTENT-WELDED

NOTES:
1. Where Y is greater than 1/16 inch as a nominal condition, S shall be increased by an amount equal to the excess of the opening above 1/16 inch.
2. L minimum = 8 times S, but in no case less than 1-1/2 inches.
3. L maximum = 24 times thinner member, but in no case more than 6 inches.
4. C maximum = 48 times thinner member, but in no case more than 12 inches.
5. The specific length of the fillet shall be the length of the weld at full size. Crater and tapered ends shall not be included when measuring dimension L.
6. Fillet size(s) shall be determined in accordance with the requirements of the applicable fabrication document.

FIGURE 22. Tee joints, partial penetration, PT2S.1, PT2S.2, PT2S.3.

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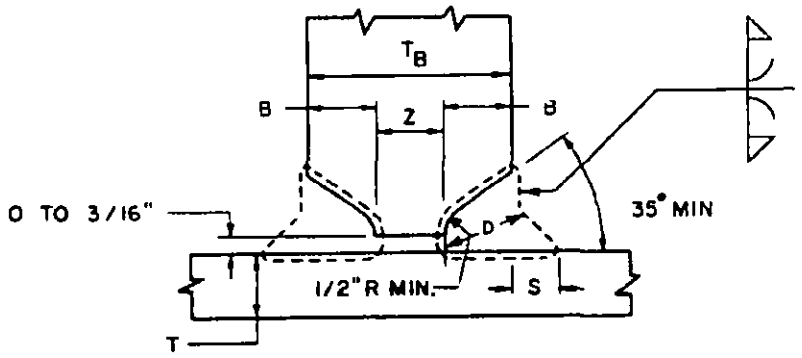
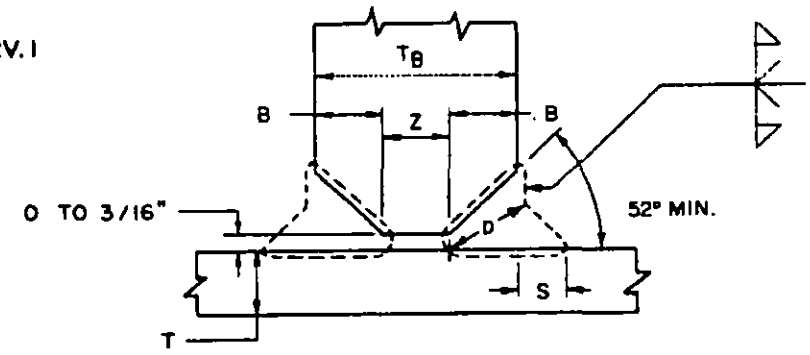
PT2J.1



PT2V.1



SH9033A

NOTES:
1. When the calculated land dimension is not greater than 3/16 inch, a full penetration weld shall be used.
2. Alternate methods of determining a depth of bevel "B" and corresponding size of reinforcing fillet "S" may be used provided each such joint is individually sketched or checked to assure that the required effective width of weld "D" will be obtained. However, in no case shall the reinforcing fillet be smaller than 1/2T or 3/8 inch whichever is less.

FIGURE 23. Tee joints, (high efficiency) fillet-reinforced, double-bevel, partial penetration, PT2J.1, PT2V.1.

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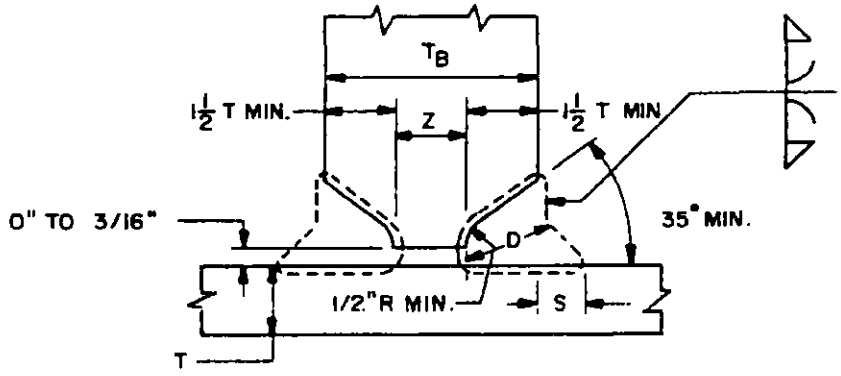
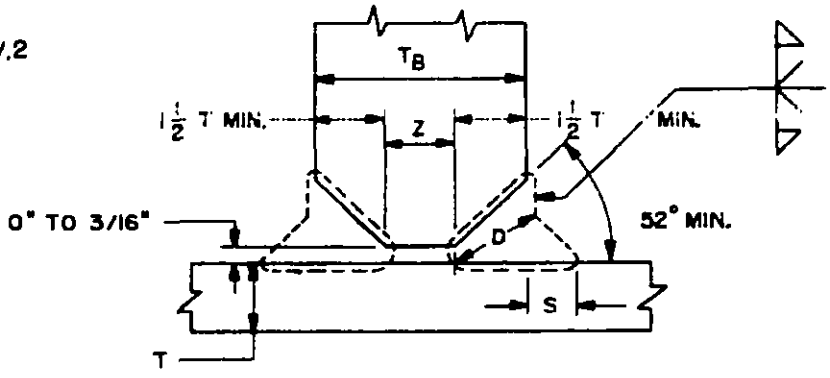
PT2J.2



PT2V.2



SH 11187

NOTES:
1. For use when "Z" is 1/2 inch or greater.
2. "S" shall be T/2 or 3/8 inch whichever is less.

FIGURE 24. Tee joint, fillet-reinforced, double-bevel, partial penetration, PT2J.2, PT2V.2.

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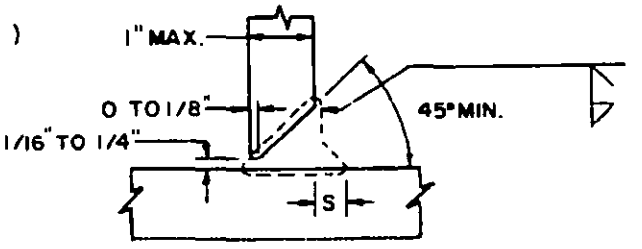
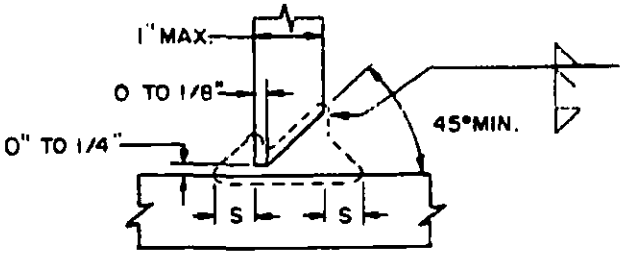
T1V.3 (SEE NOTE)



WELDED ONE SIDE

T2V.1



WELDED BOTH SIDES

NOTE: Joints welded from one side shall not be used when root of weld is subject to bending tension stress equivalent to one-half the yield strength of the base metal or greater.

FIGURE 25. Tee joint, fillet-reinforced, single-bevel, T1V.3, T2V.1.

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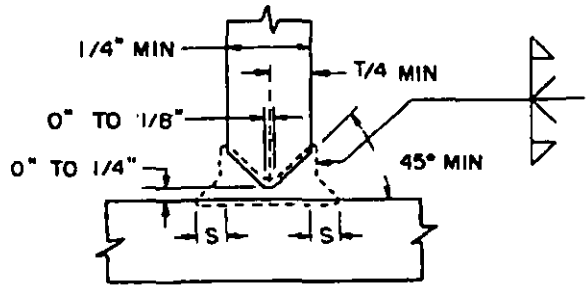
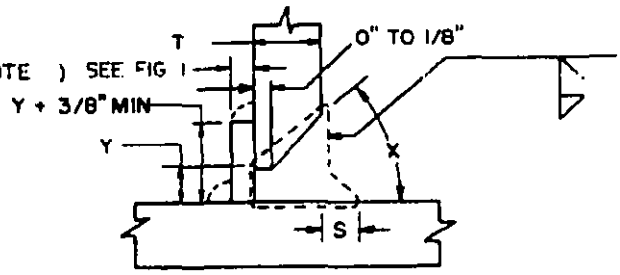
T2V.2



DOUBLE-BEVEL

T1V.1
T1V.2 (SEE NOTE) SEE FIG 1



SH1495B

SINGLE-BEVEL

Joint number	Angle X (min) degrees	Dim Y (min) inch	Dim T inches
T1V.1 T1V.2	45 35	1/4 3/8	Unlimited

NOTE: Backing may be removed and joint welded on both sides. If joint is not welded from both sides, the joint shall not be used when the root of the weld is subject to bending tension stress equivalent to one-half the yield strength of the base metal or greater.

FIGURE 26. Tee joint, fillet-reinforced, T2V.2, T1V.1, T1V.2.

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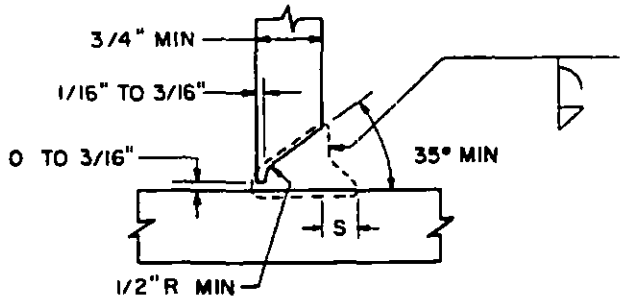
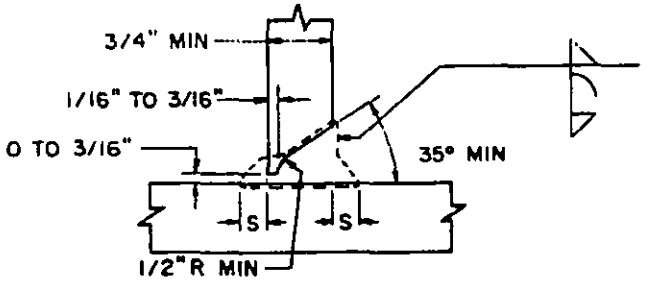
T1J.1 (SEE NOTE)



WELDED ONE SIDE

T2J.1



SH14960

WELDED BOTH SIDES

NOTE: Joints welded from one side shall not be used when root of weld is subject to bending tension stress equivalent to one-half the yield strength of the base metal or greater.

FIGURE 27. Tee joint, fillet-reinforced, single-J, T1J.1, T2J.1.

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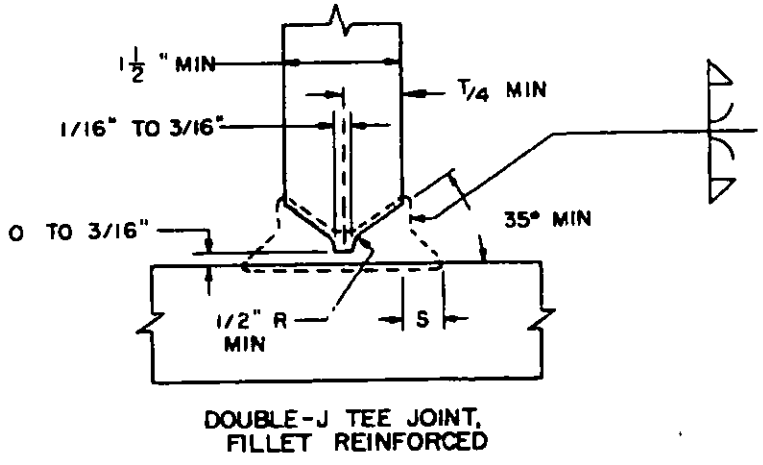
T2J.2



3H9032A

FIGURE 28. Tee joint, fillet-reinforced, double-J, T2J.2.

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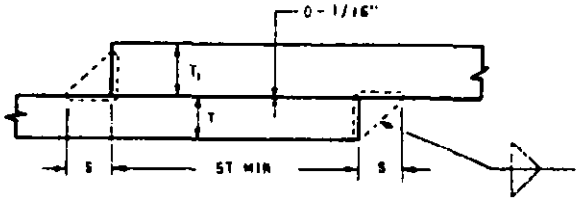
L2S.1 (SEE NOTE)



NOTE: Size of fillet shall be as governed by design requirements.

FIGURE 29. Lap joint, double-fillet-welded, L2S.1.

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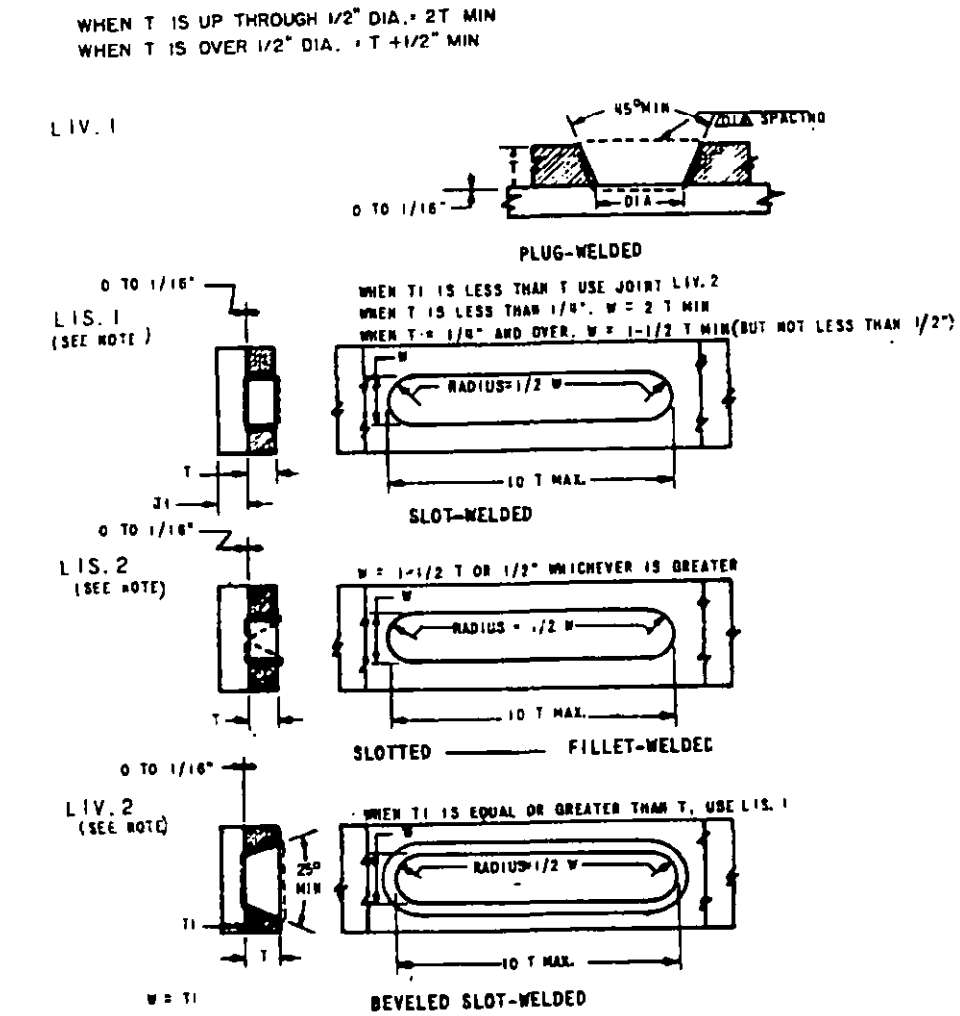

NOTE: When T is less than 1/2 inch, slot shall be beveled to a 45-degree included angle.

FIGURE 30. Lap joints, L1V.1, L1S.2, L1V.2.

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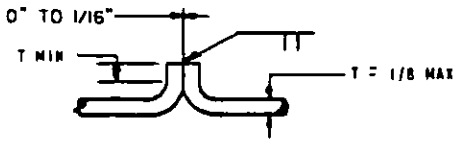
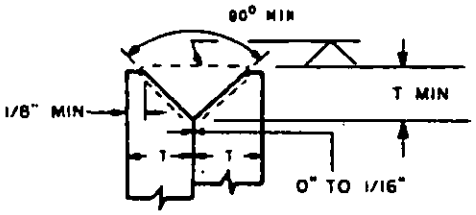
E1S.1 (SEE NOTE)



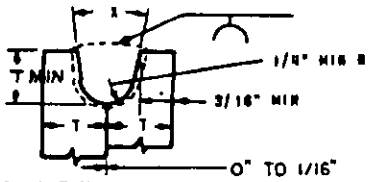
SQUARE-GROOVED

E1V.1 (SEE NOTE)



SINGLE-V

E1U.1
E1U.2 (SEE NOTE)



SINGLE-U

SH1490B

Joint number	Angle X (min) degrees	Welding position
E1U.1	45°	All
E1U.2	20°	Flat,vert,over

NOTE: This joint shall not be used when root of weld is subject to bending tension.

FIGURE 31. Edge joints, E1S.1, E1V.1, E1U.1, E1U.2.

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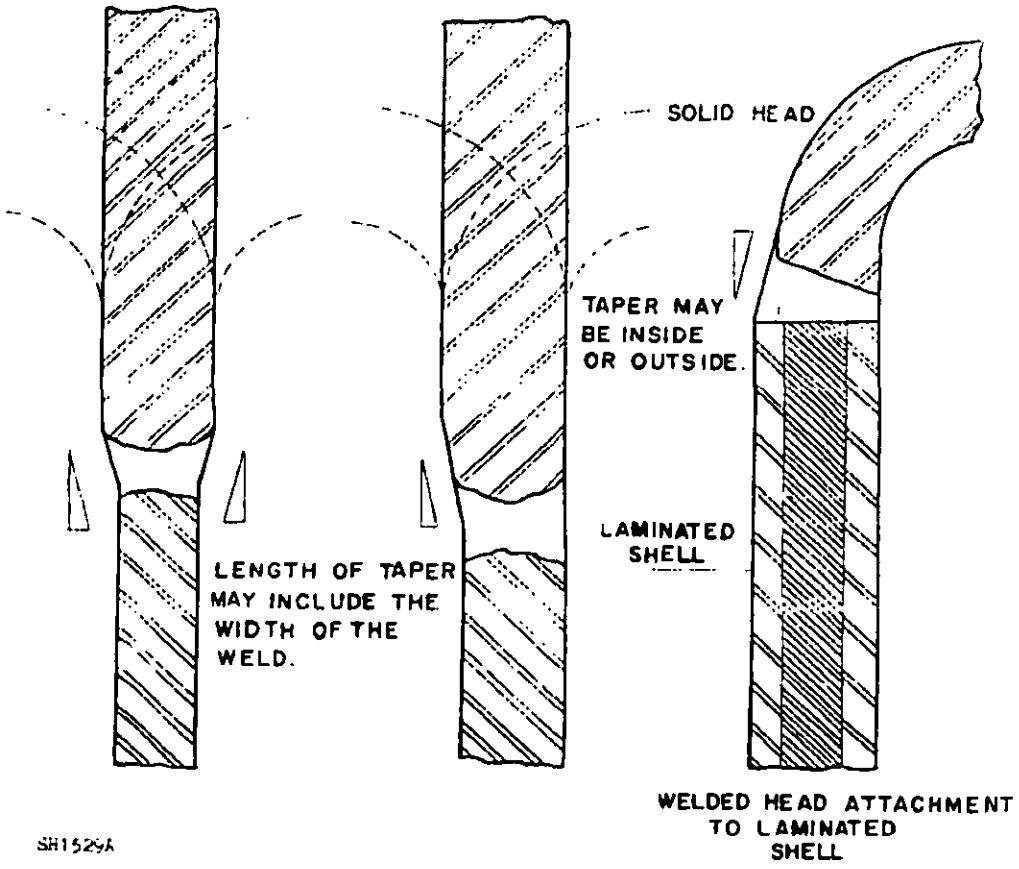
SOLID HEAD
TAPER MAY BE INSIDE OR OUTSIDE.
LAMINATED SHELL
LENGTH OF TAPER MAY INCLUDE THE WIDTH OF THE WELD.
WELDED HEAD ATTACHMENT TO LAMINATED SHELL
SH1529A

NOTE: Limits for differences in plate thickness without beveling:

Thin plate thickness	Thickness difference (max)
Up to 1/2 inch	1/8 inch
over 1/2 to 1 inches	3/16 inch
over 1 inch	1/4 inch

The transition between members of unequal thickness, greater than those shown above, shall require chamfering of the thicker member down to the thickness of the thinner member. For submarines, the taper shall be 4:1 minimum. For surface ships, the taper shall be 2:1 minimum.

FIGURE 32. Butt-welding plates of unequal thickness.

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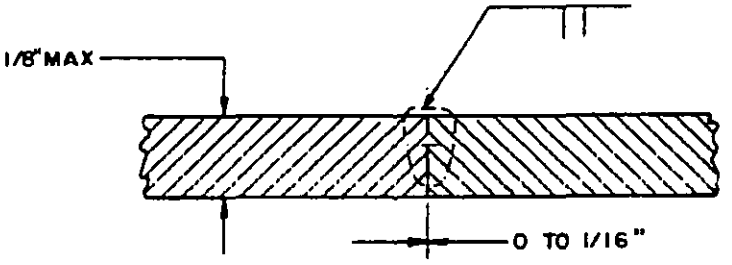
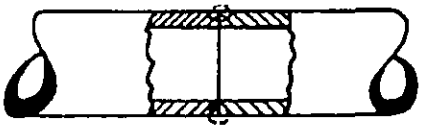
P-1





SH0706

FIGURE 33. Butt joint, square, P-1.

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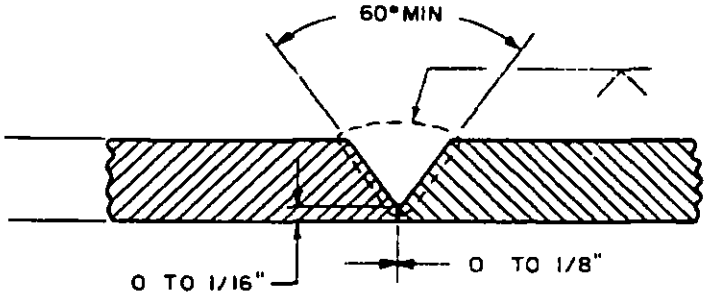
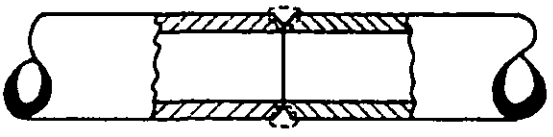
P-2





SH1508B

FIGURE 34. Butt joint, V-groove, P-2.

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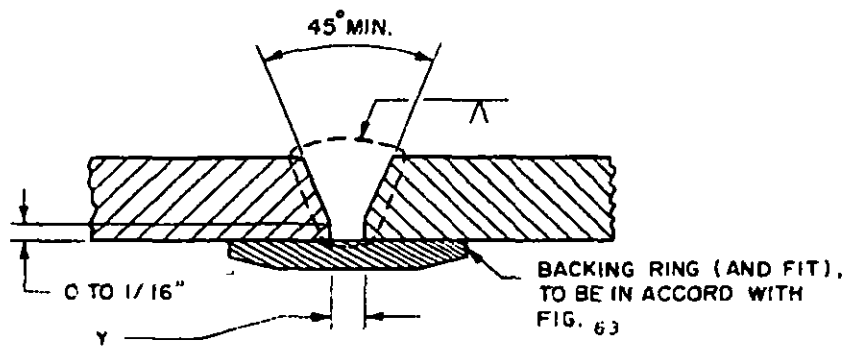
P-3



SH15G1B

Pipe size	Y (root opening)
3 inch IPS and under	3/16 inch min
Over 3 inch IPS	1/4 inch min

FIGURE 35. Butt joint, welded on permanent backing ring, V-groove, P-3.

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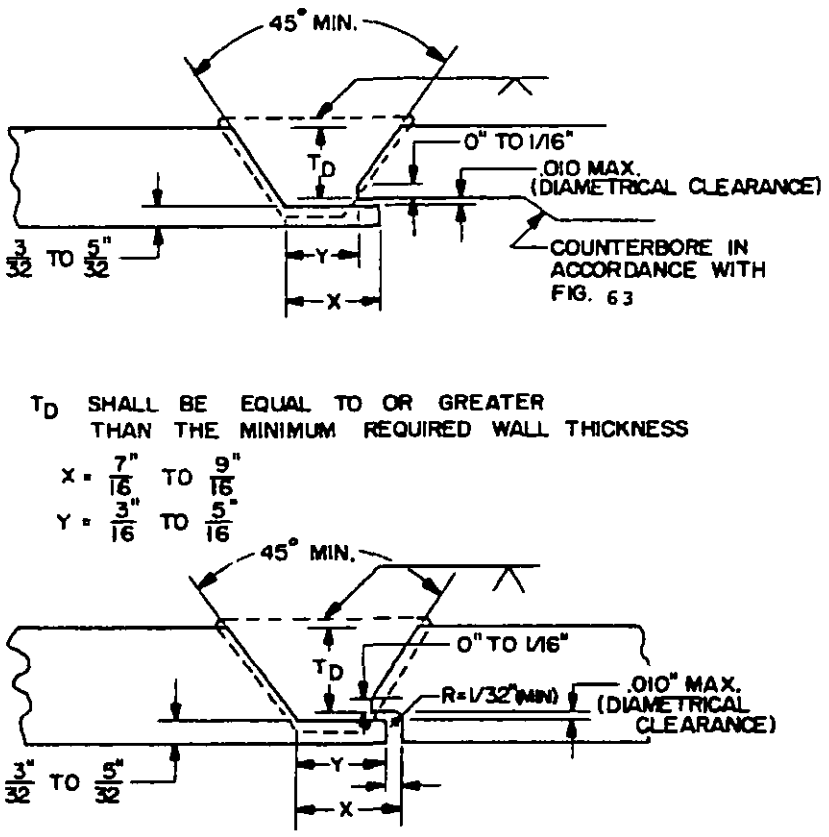
P - 4



SH 11188

FIGURE 36. Butt joint welded on permanent, integral backing ring, V-groove, P-4.

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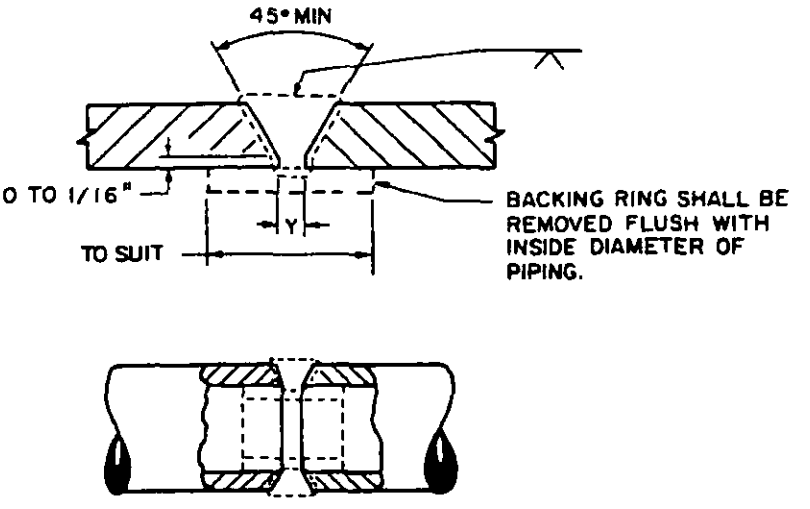
P-5



SH1506B

Pipe size	Y(root opening)
3 inch IPS and under	3/16 inch min
Over 3 inch IPS	1/4 inch min

FIGURE 37. Butt joint, welded on removable backing ring, V-groove, P-5.

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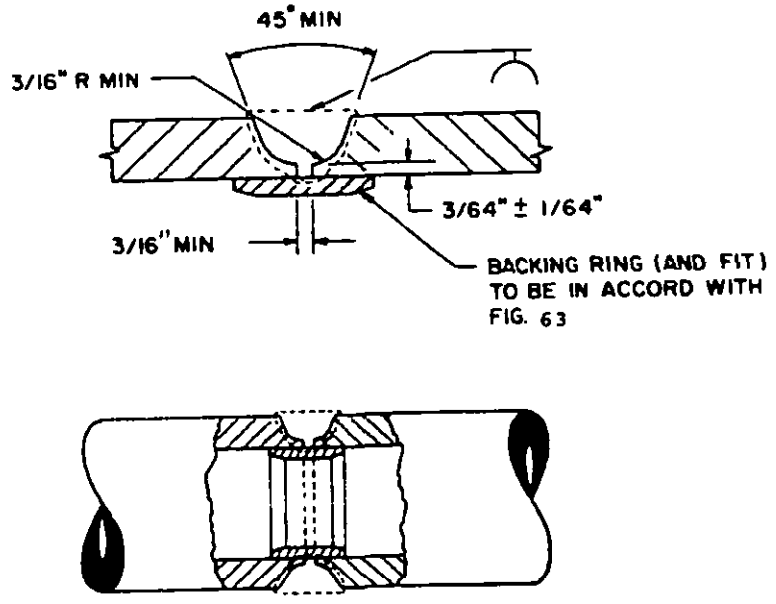
P-6



SH9034A

FIGURE 38. Butt joint, welded on permanent backing ring, U-groove, P-6.

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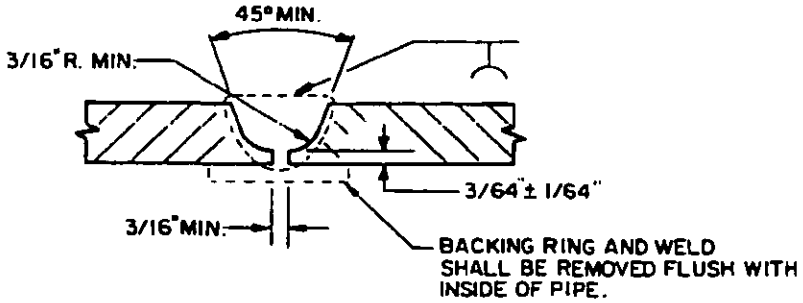
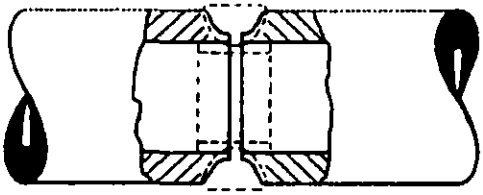
P7





SH9C35A

FIGURE 39. Butt joint, welded on removable backing ring, U-groove, P-7.

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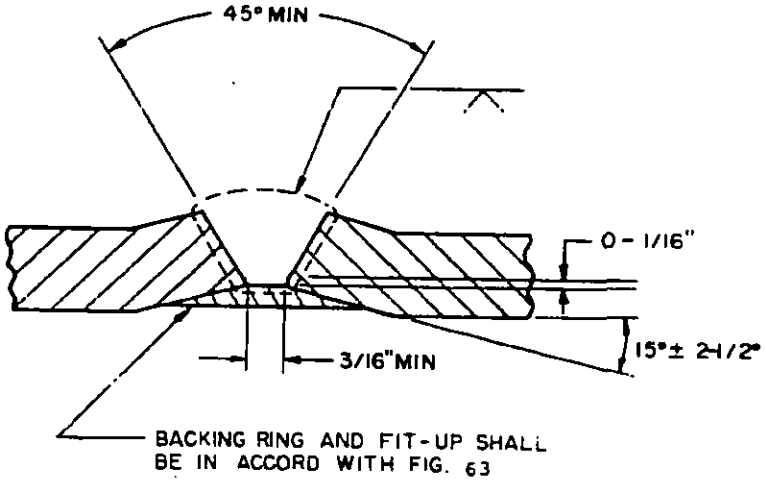
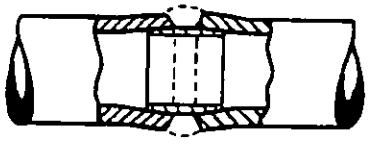
P-8





8H15028

FIGURE 40. Butt joint, welded on flared type backing ring, V-groove, P-8.

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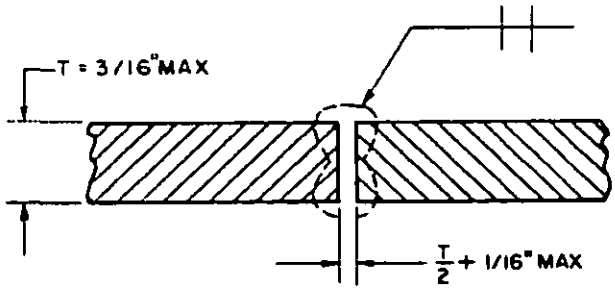
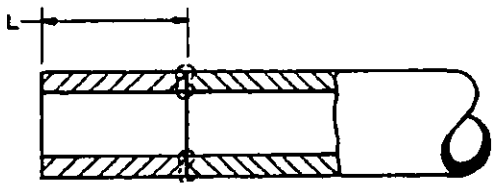
P-9





SH1503B

IPS	L max
inches	inches
2-1/2	4
3	5
3-1/2	6
4	8
5	10
6	12
8	16
10	20
12	24

FIGURE 41. Butt joint, welded both sides, square, P-9.

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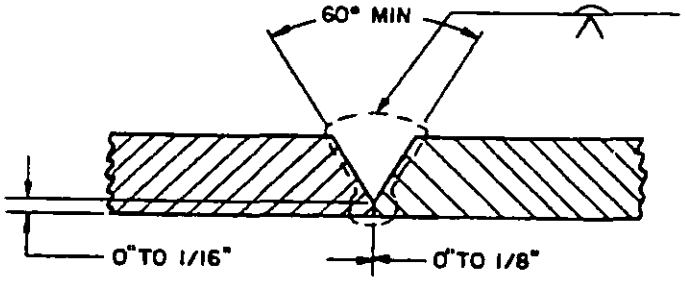
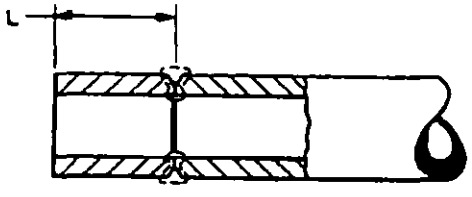
P-10





SH1504B

IPS	L max
inches	inches
2-1/2	4
3	5
3-1/2	6
4	8
5	10
6	12
8	16
10	20
12	24

FIGURE 42. Butt joint, welded both sides, V-groove, P-10.

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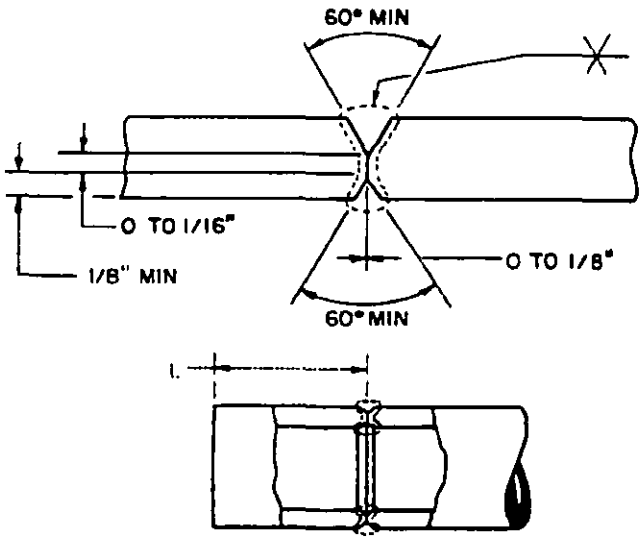
P-11



SH15C5B

IPS	L max
inches	inches
2-1/2	4
3	5
3-1/2	61
4	8
5	10
6	12
8	16
10	20
12	24

FIGURE 43. Butt joint, welded both sides, double V-groove, P-11.

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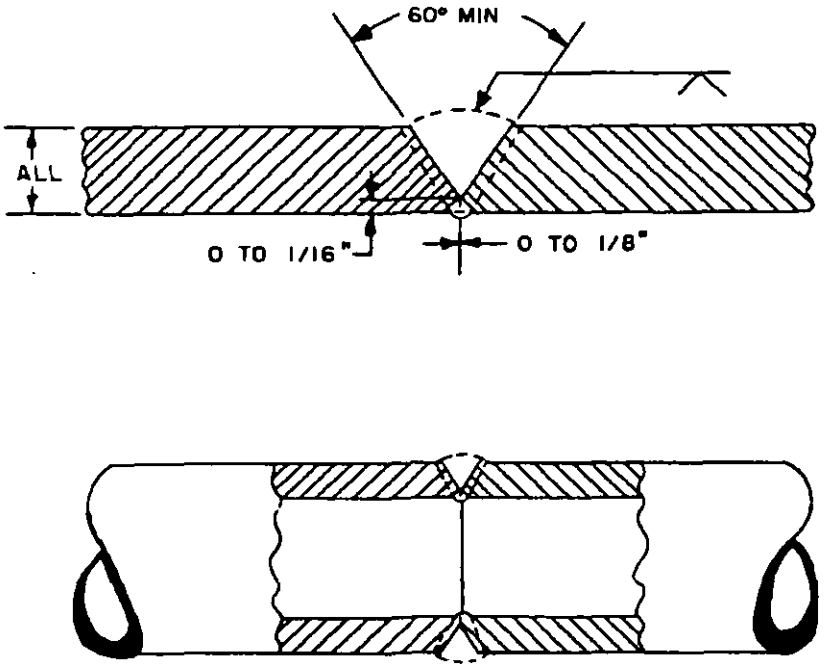
P - 12



SH9700

FIGURE 44. Butt joint, automatic welded one side, V-groove, P-12.

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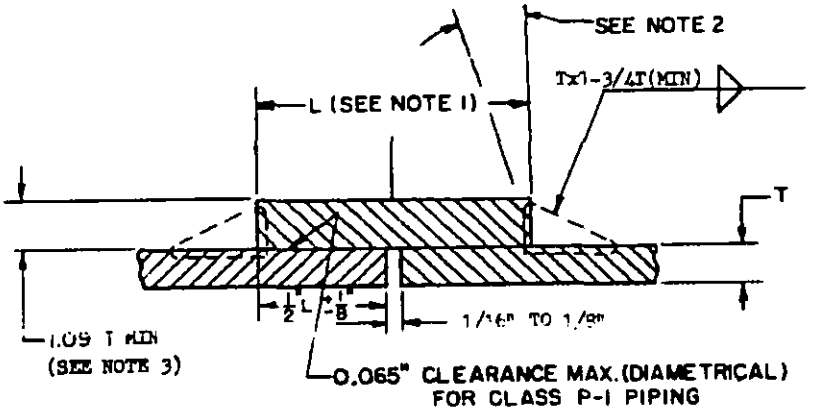
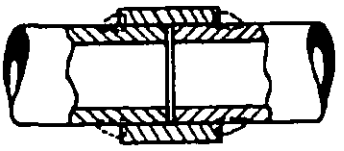
P-13





SH1499B

NOTES:
1. L min. shall be as follows: 1 inch for less than 3/4 inch IPS, 1-1/2 inch for over 3/4 inch for 3 inch IPS, 2 inch for over 3 inch IPS.
2. Up to 22 degree bevel may be permitted.
3. Maximum socket thickness shall be in accordance with the applicable fitting or component drawing.

FIGURE 45. Fillet welded, slip-on coupling, P-13.

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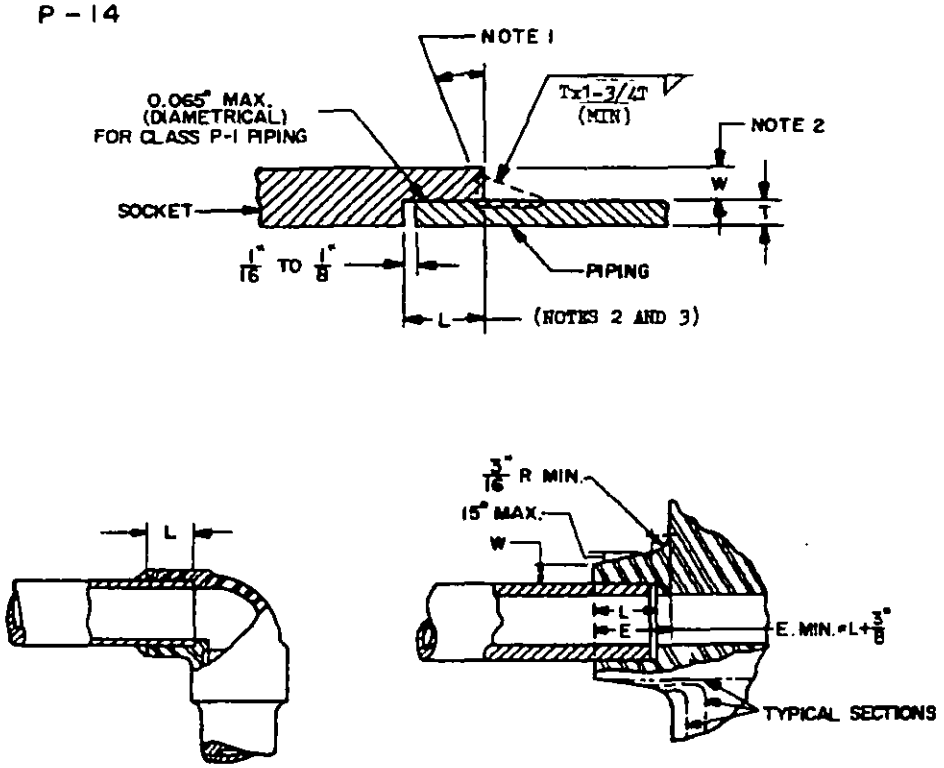
P - 14



SH 11189

NOTES:
1. Up to 22 degree bevel may be used.
2. Wall thickness (W) and minimum socket depth (L) shall be in accordance with the applicable specification for the fittings.
3. For repairs where the weldment and the pipe must be removed, the existing fitting, with reduced socket depth, may be reused under the following conditions:
   (a) The pipe end gap clearance shall be held to 1/16 inch maximum.
   (b) If the diametrical clearance between the pipe and the fitting is 0.025 inch and less, the L dimension may be reduced by 50 percent of the specified dimension.
   (c) If the diametrical clearance is greater than 0.025 inch, but is within 0.065 inch, the L dimension may be reduced by 25 percent of the specified dimension.
4. The provisions of note 3 do not apply if the diametrical clearance exceeds 0.065 inch.
5. The provisions of note 3 are not applicable to systems classified under "SUBSAFE". For SUBSAFE systems, fittings with reduced socket depth shall not be used without specific approval by NAVSEA.

FIGURE 46. Socket, fillet welded, P-14.

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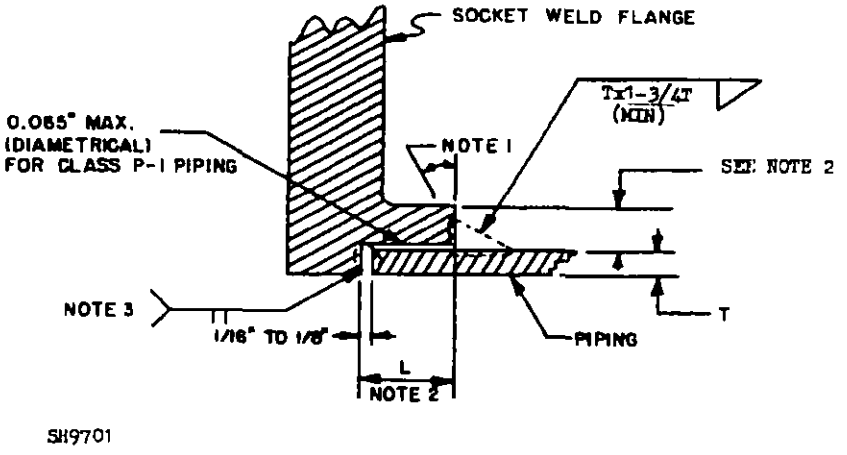
P-15



NOTES:
1. Up through 22 degree bevel may be permitted.
2. Flange thickness and minimum socket depth (L) shall be in accordance with the applicable specification for the flange.
3. Seal weld required when used for salt water and other corrosive fluids, and base material is not resistant to crevice corrosion.

FIGURE 47. Socket flange, fillet-welded, P-15.

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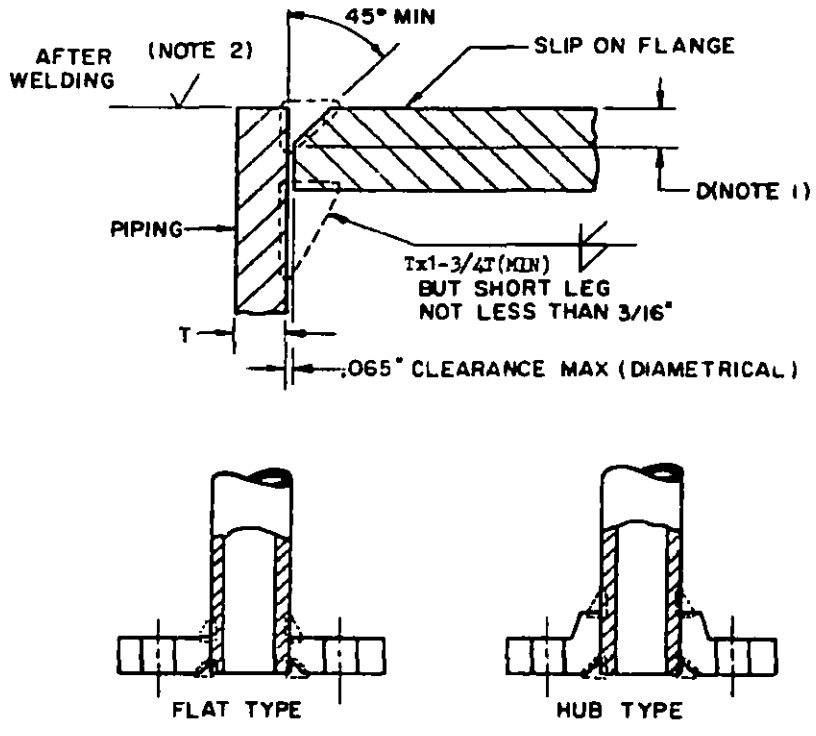
P-16



NOTES:
1. Dimension "D" to be as follows:

Pipe size (IPS)	Dim "D" (inches)
Through 2 inches	3/16
2-1/2 inches through 7 inches	1/4
8 inches through 16 inches	5/16

2. Final machined surface shall have a maximum surface roughness of 125 RHR.

FIGURE 48. Welded slip-on flange, fillet-reinforced, single-bevel, P-16.

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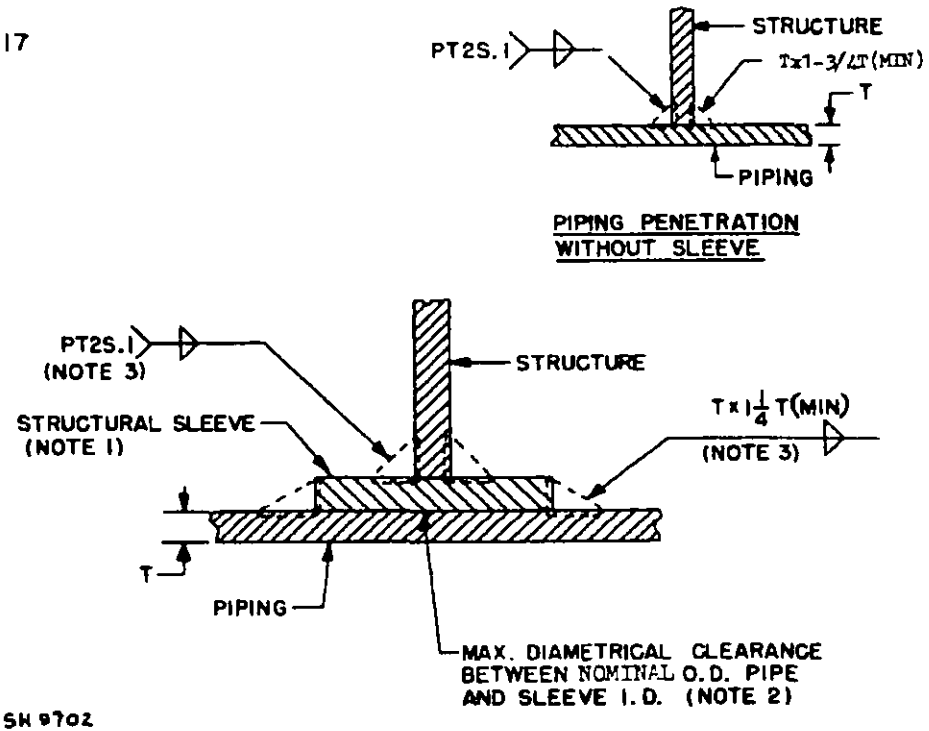
P-17



NOTES:
1. The design of the sleeve shall be as specified on the applicable sleeve drawing.
2. Maximum diametrical clearance shall be as follows:
   1/16 inch - for 1/4 inch IPS through 3-1/2 inch IPS
   1/8 inch - for 4 inch IPS through 8 inch IPS
   3/16 inch - above 8 inch IPS
3. The applicable installation drawing shall specify whether one or both ends of the sleeve shall be welded to the pipe.

FIGURE 49. Structural sleeve for piping penetration, fillet welded, P-17.

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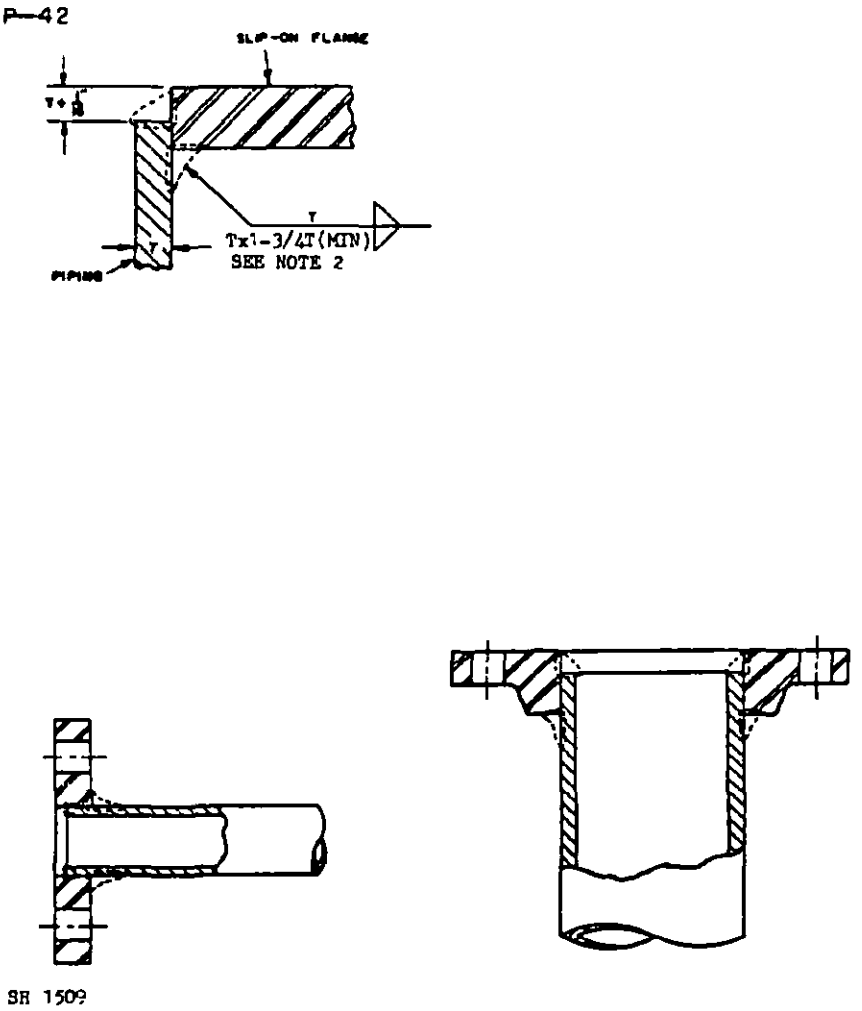

NOTES:
1. This joint shall not be used with butterfly valves, spiral wound gaskets, or flanged joints in oil systems.
2. T x 1-3/4T(minimum) (but the short leg shall not be less than 3/16 inch).

FIGURE 50. Double-fillet welded slip-on flange, P-42.

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P-60

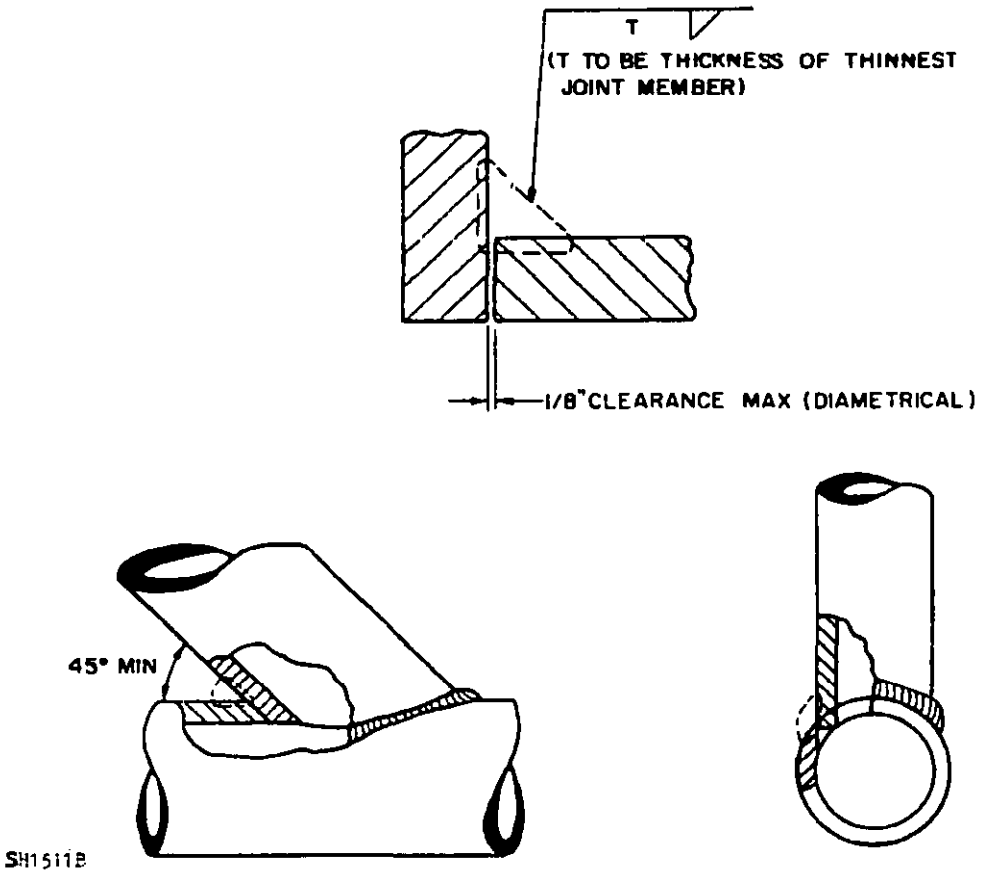

FIGURE 51. Branch connection, internal fillet-welded, P-60.

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P-61

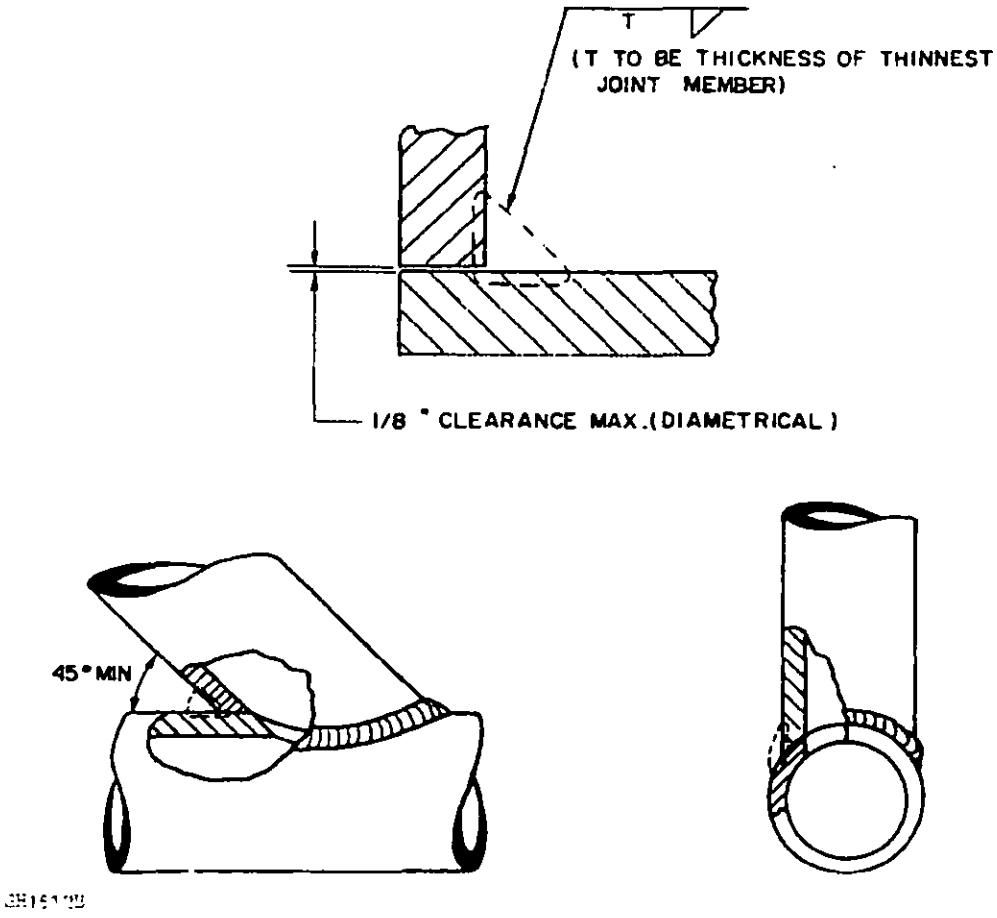

FIGURE 52. Branch connection, external fillet-welded, P-61.

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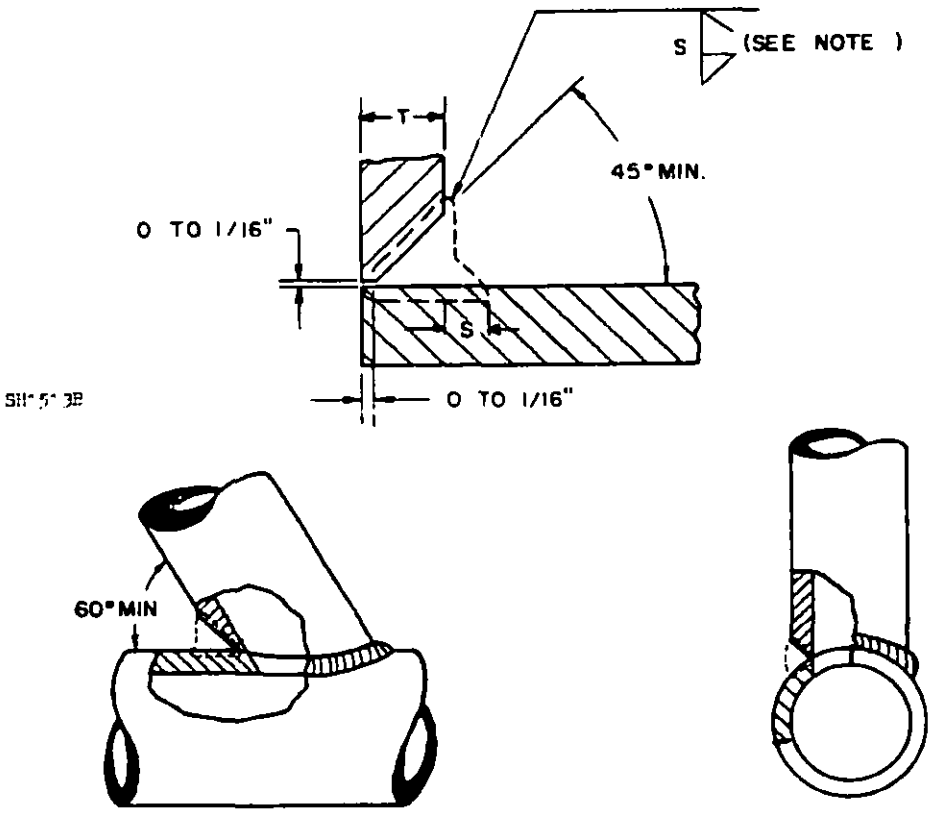
P-62



NOTES: S = 1/2T or 3/16 inch, whichever is less. Where additional reinforcement is required, "S" shall be as specified by design.

FIGURE 53. Branch connection, welded on one side, external fillet-reinforced, single-bevel, P-62.

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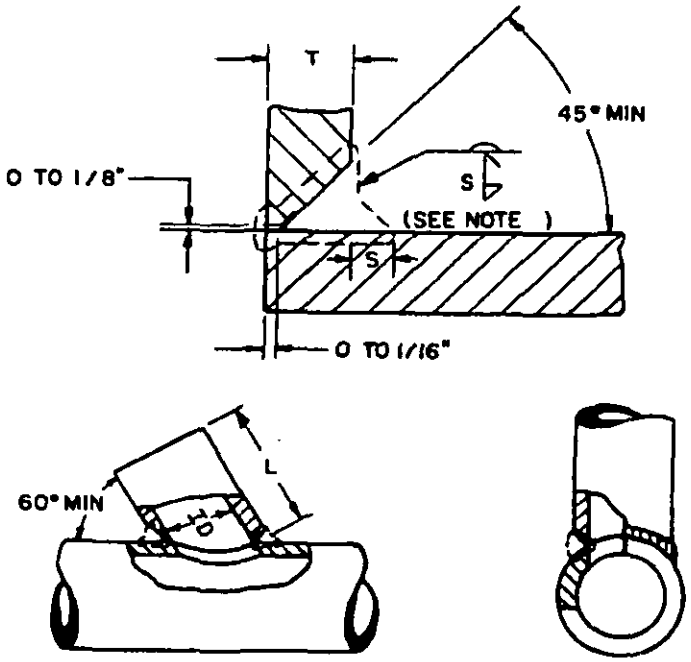
P-63



SH1514B

IPS	Up to 12 inches	12 inches to 24 inches	24 inches and over
L max	I.D.	1-1/2 x I.D.	Unlimited

NOTE: S shall be 1/2T or 3/16 inch whichever is less. Where additional reinforcement is required, "S" shall be as specified by design.

FIGURE 54. Branch connection, welded both sides, external fillet-reinforced, single-bevel, P-63.

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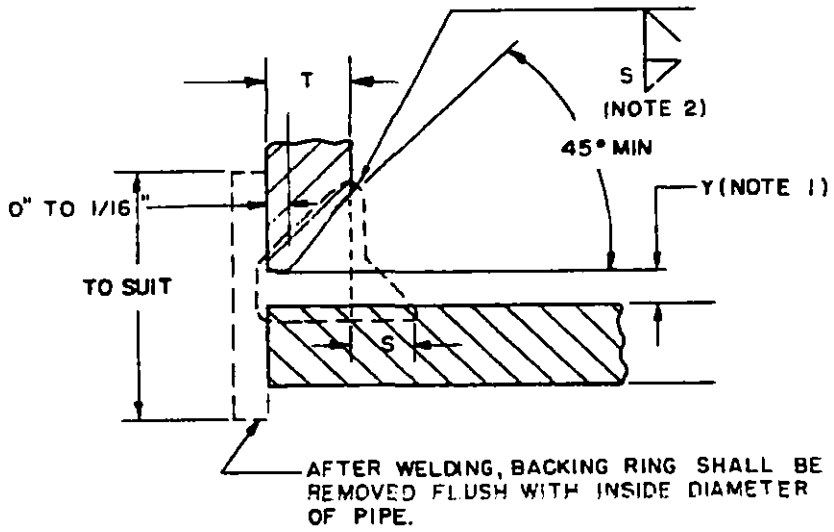
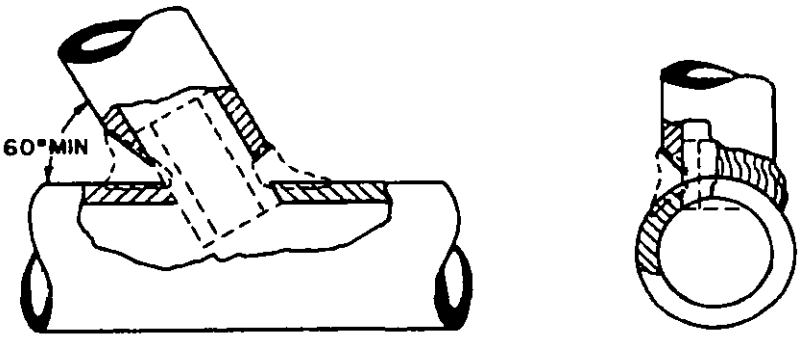
P-64





SH1515B

NOTES:
1. Root openings (Y) for use with backing rings: Pipe sizes 3 inches or less, 3/16 inch min.; pipe sizes over 3 inches, 1/4 inch min.
2. S = 1/2T or 3/16 inch, whichever is less. Where additional reinforcement is required, "S" shall be as specified by design.

FIGURE 55. Branch connection, welded on removable backing ring, external fillet-reinforced, single-bevel, P-64.

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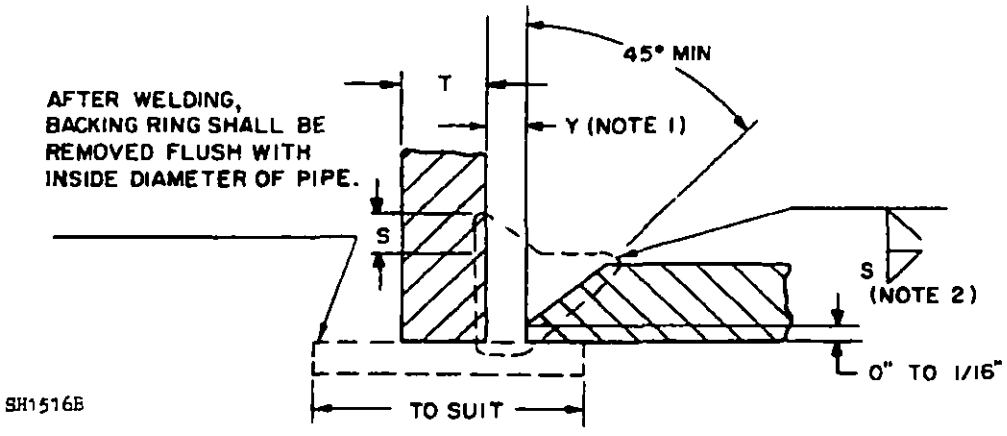
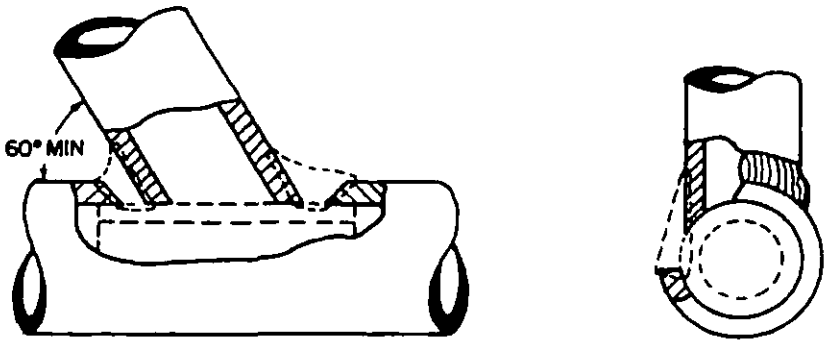
P-66





NOTES:
1. Root openings (Y) for use with backing rings: Pipe sizes 3 inches or less, 3/16 inch min.; pipe sizes over 3 inches, 1/4 inch min.
2. S = 1/2T or 3/16 inch, whichever is less. Where additional reinforcement is required, "S" shall be as specified by design.

FIGURE 56. Branch connection, welded on removable backing ring, internal fillet-reinforced, single-bevel, P-66.

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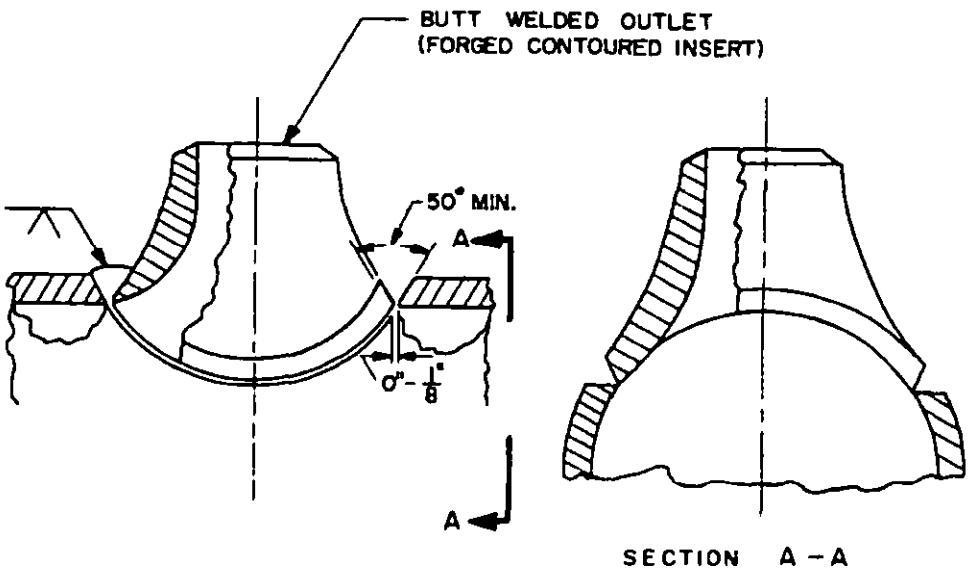
P – 67



SH 11190

NOTE: Pressure and temperature combination shall be in accordance with the rating of the outlet.

FIGURE 57. Integrally reinforced branch connection, welded on one side, single-bevel, P-67.

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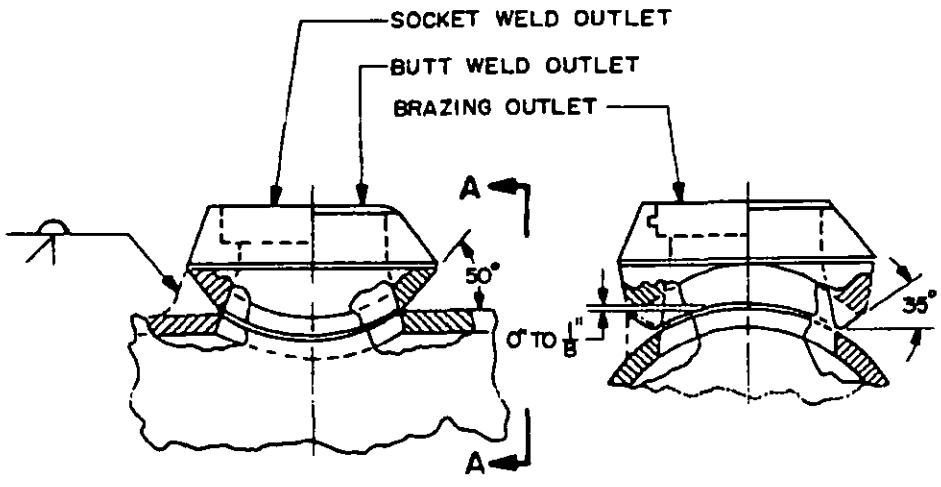
P – 68



SH 9704

NOTE: Pressure and temperature combination shall be in accordance with rating of fitting.

FIGURE 68. Integrally reinforced fitting, branch connection, welded on one side or both sides, single-bevel, P-68.

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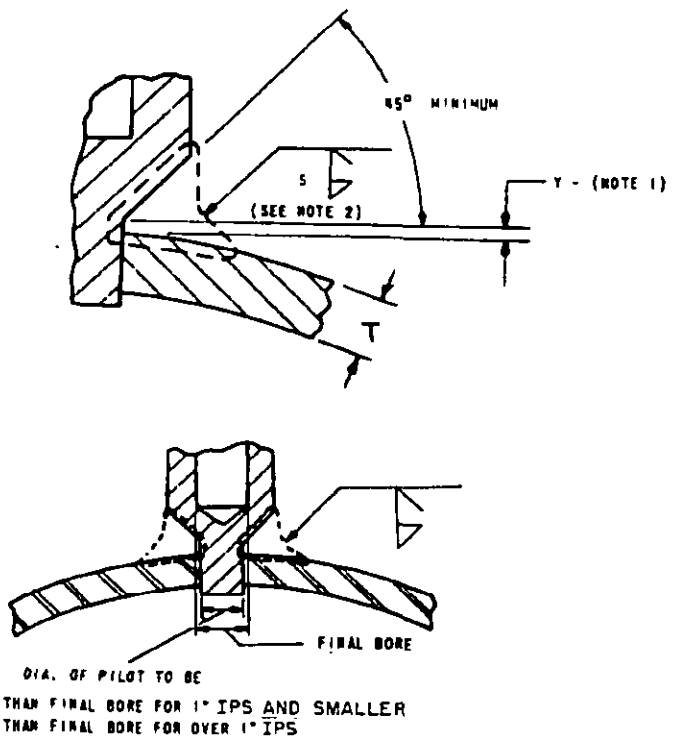
P-70


45° MINIMUM
S
(SEE NOTE 2)
Y - (NOTE 1)
T
FINAL BORE
DIA. OF PILOT TO BE
3/16" LESS THAN FINAL BORE FOR 1" IPS AND SMALLER
1/4" LESS THAN FINAL BORE FOR OVER 1" IPS

SH90374

NOTES:
1. Root openings (Y) shall conform to the following: pipe sizes 3 inches or less; 3/16 inch minimum; pipe sizes over 3 inches, 1/4 inch minimum.
2. For bosses designed as integrally reinforced branch fittings, size of fillet S shall be 1/2T or 3/16 inch, whichever is less.

FIGURE 59. Branch connection with pilot, fillet-reinforced, single-bevel, P-70.

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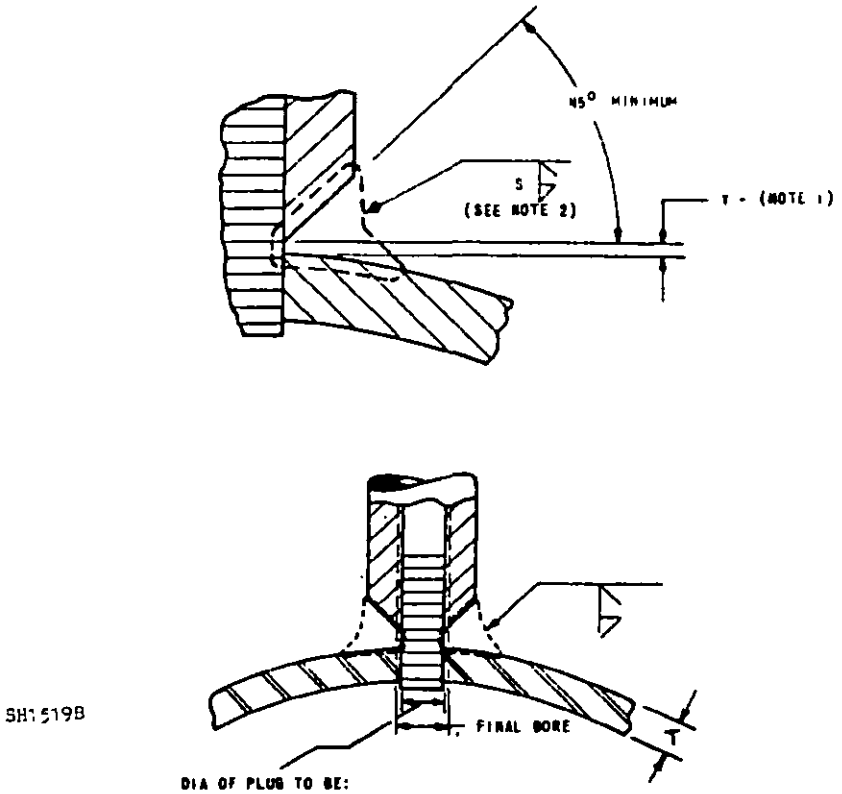
P-71



NOTES:
1. Root openings (Y) shall conform to the following: pipe sizes 3 inches or less, 3/16 inch minimum; pipe sizes over 3 inches, 1/4 inch minimum.
2. For bosses designed as integrally reinforced branch fittings, size of fillet(s) shall be 1/2T or 3/16 inch whichever is less.

FIGURE 60. Branch connection with plug, fillet-reinforced, single-bevel, P-71.

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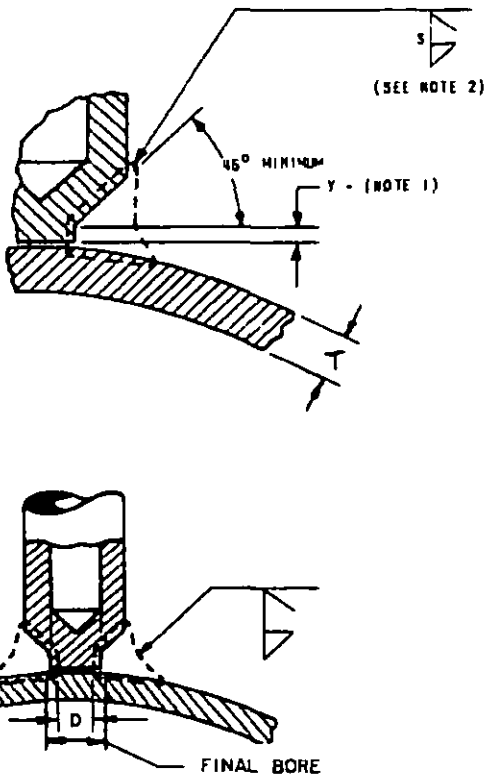
P-72



SH1520B

NOTES:
1. Root openings (Y) shall conform to the following: pipe sizes 3 inches or less, 3/16 inch minimum; pipe sizes over 3 inches, 1/4 inch minimum.
2. For bosses designed as integrally reinforced branch fittings, size of fillet(s) shall be 1/2T or 3/16 inch whichever is less.
3. Diameter of attachment (D) shall be 3/16 inch less the final bore for 1 inch IPS and smaller branch pipe; 1/4 inch less than final bore for branch pipe over 1 inch IPS.

FIGURE 61. Branch connection, without pilot, fillet-reinforced, single-bevel, P-72.

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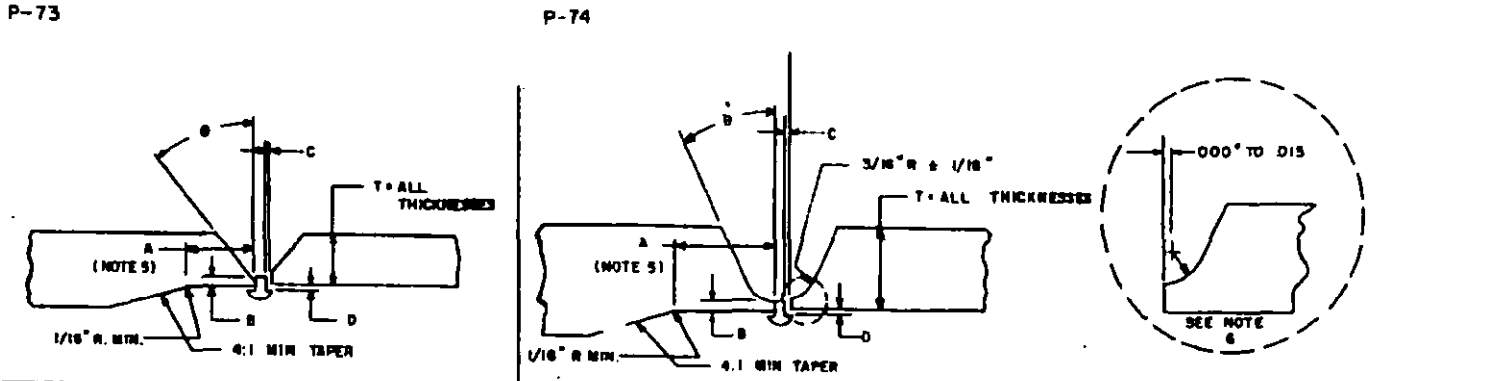

JOINT NO.	DIM "B" 1" IPS AND BELOW SEE NOTE 7	DIM "B" ABOVE 1" IPS SEE NOTE 7	DIM "C" CLEARANCE	DIM "D" DIFF IN DIA	θ SEE NOTE 3 & 8
P-73	.010" ± .005	.030" ± .005"	.031" MAX	.031" MAX	40° ± 5°
P-74	010 ± .005	.030" ± .005"	.031" MAX	.031" MAX	25 ± 3
P-75	1/16" ± 1/64"	1/16" ± 1/64"	.031" MAX	.031" MAX	40° ± 5°
P-76	1/16" ± 1/64"	1/16" ± 1/64"	.031" MAX	.031" MAX	25 ± 3
P-77	0 — 0.020"	0 — 0.020"	———	.031" MAX	40° ± 2-1/2°

SEE NOTES 1 THROUGH 8

FIGURE 62. Consumable insert butt joints, V-groove, and U-groove, P-73 through P-77.

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Notes to figure 62:

1. Consumable insert dimensions shall be in accordance with MIL-I-23413.
2. Use of insert rings shall be verified by procedure approval for the specific application.
3. For pipe to be welded in the vertical axis position, θ on the low side of the joint may be as follows, provided the total included angle is 2 times the angle θ specified in the table:
   (a) 30 degrees ± 3 degrees for P-73 and P-75.
   (b) 8 degrees ± 3 degrees for P-74 and P-76.
4. Consumable inserts of geometries different from those shown herein or in MIL-I-23413 may be used following welding procedure approval, by an authorized agent as identified in 3.2.
5. The depth of counterbore "A" may be obtained by machining, expanding or forming and shall be 3/8 inch minimum or T minimum whichever is greater, except that on elbows, "A" shall be limited to a depth which will not reduce the wall thickness below the minimum allowable value. In no case shall "A" be less than 1/8 inch.
6. Center of radius shall be located so that the plane of the root face will extend not more than 0.015 inch from the nominal position shown. (See insert sketch for joint type P-74.)
7. For joints of nickel-copper (S-42) and nickel-chromium-iron (S-43) materials dimensions "B" may be changed to 1/16 inch + 1/64 inch for joint P-74.
8. For joints of nickel-copper materials dimension "θ" may be changed to 47-1/2 degrees ± 2-1/2 degrees for joint P-73.

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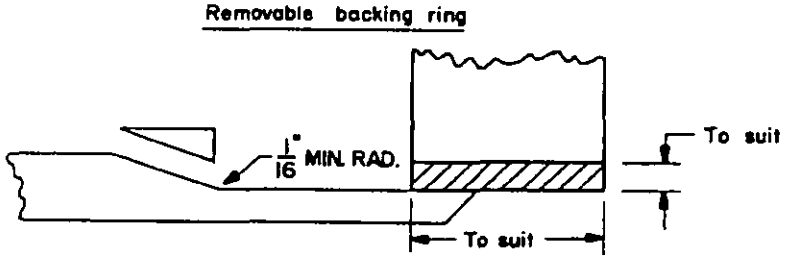

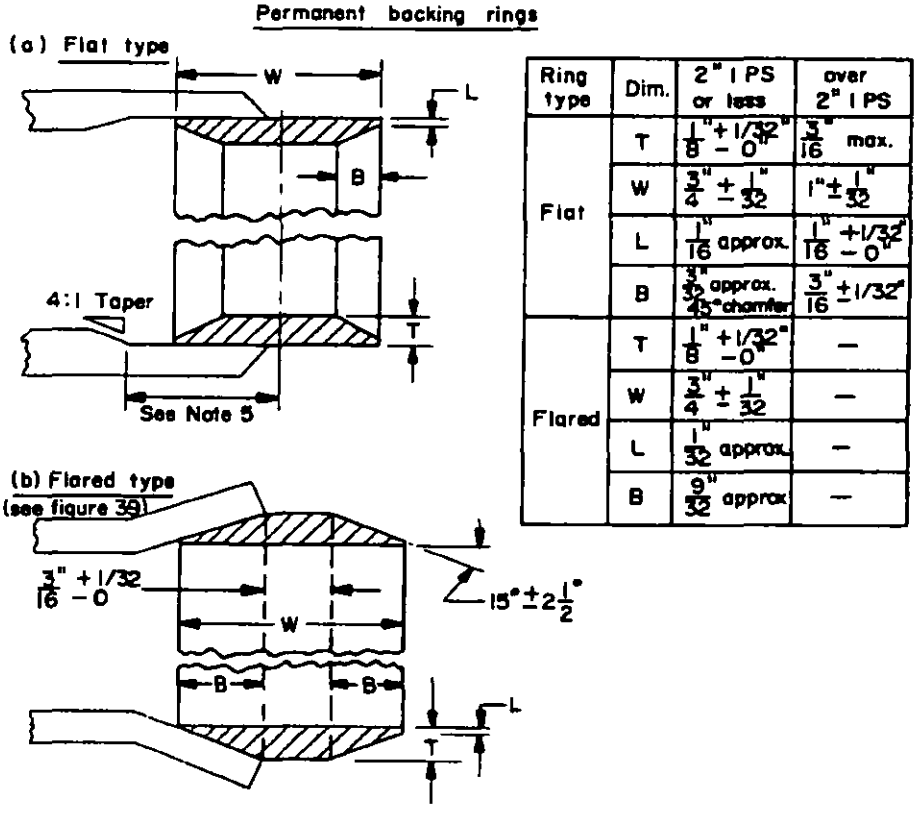

Ring type	Dim.	2" I PS or less	over 2" I PS
Flat	T	1/8" +1/32" -0"	3/16" max.
	W	3/4" ± 1/32"	1" ± 1/32"
	L	1/16" approx.	1/16" +1/32" -0"
	B	3/32" approx. 45° chamfer	3/16" ±1/32"
Flared	T	1/8" +1/32" -0"	—
	W	3/4" ± 1/32"	—
	L	1/32" approx.	—
	B	9/32" approx.	—

SH 1119J

FIGURE 63. Backing rings for welded pipe joints.

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Notes to figure 63:

1. Rings may be solid or split type. For class P-1 piping, permanent split type rings, if used, shall be welded after fitting and prior to final insertion in the pipe. (When split type rings are welded, defects that can be identified as being in the backing ring butt weld shall not be cause for rejection.) For class P-2 piping, backing ring butts need not be welded.
2. Backing rings may be furnished with spacers as follows:

   (a) A minimum of 3 spacers shall be located around the outer surface of the backing ring to maintain a minimum root opening.
   (b) No portion of the ring other than the spacers shall project beyond the outer surface of the backing ring.
   (c) Removable spacers shall not require, or result, in removal of material from the backing ring for a depth of more than one-half the thickness of the ring.
   (d) When used, non-removable spacers shall be constructed to permit complete fusion of the spacers into the backing ring and the welding groove without causing weld defects. A spacer having a cross-sectional area greater than 0.125 square inches and a height of more than one-half thickness of the ring shall not be permitted. (Push-out type spacers shall show blank dots on radiograph.)

3. Backing rings may be tack welded inside or outside.
4. Backing rings shall not have a diametrical clearance of more than 0.045 inch for pipe sizes 2 inch IPS and smaller and 0.065 inch for pipe sizes 2-1/2 inch IPS and larger.
5. The depth of counterbore may be obtained by machining, expanding, or forming and shall be 1/2 inch (minimum) or T (minimum) whichever is larger to insure proper pipe inside diameter in way of joint. Counterbore for elbows shall be limited to a depth which will not reduce wall thickness below design minimum.
6. Pipe tapers less than 4:1 are acceptable provided they meet the requirements of approved ANSI fittings or applicable drawings.

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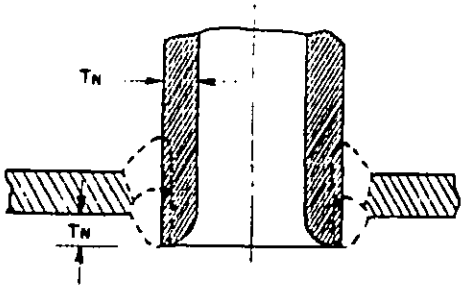
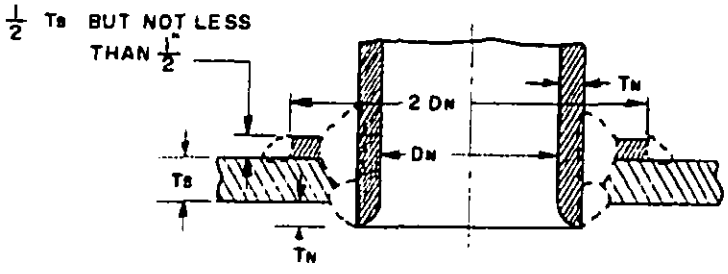
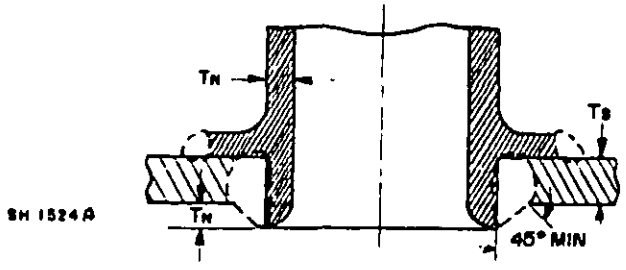
V-4



V-5



V-6



SH 1524A

*FIGURE 64. Root connections, V-4, V-5 and V-6.

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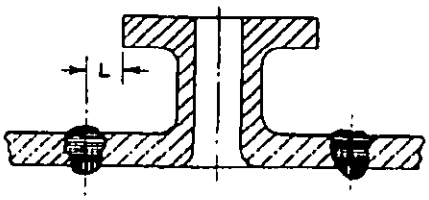
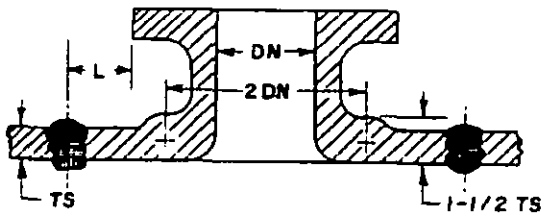
V-7



V-8



SH 526B

Note: L dimension shall be such as to permit radiography of the entire weld without interference by the nozzle flange.

FIGURE 65. Nozzle joints, V-7 and V-8.

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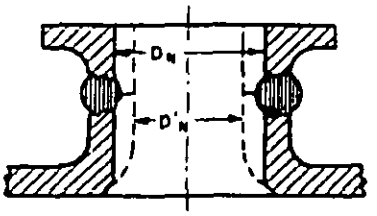
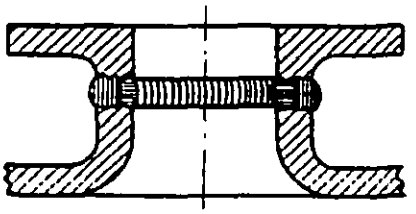
V-9

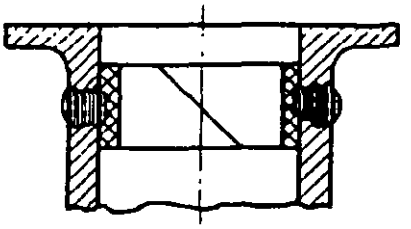


INSIDE DIAMETER D'_N IS THE DIAMETER BEFORE WELDING. AFTER WELDING THE JOINT SHALL BE FINISHED BY MACHINING OR DRILLING THE INSIDE WALL TO DIAMETER D_N.

V-11



V-12



SH1527A

FIGURE 66. Nozzle joints, V-9, V-11 and V-12.

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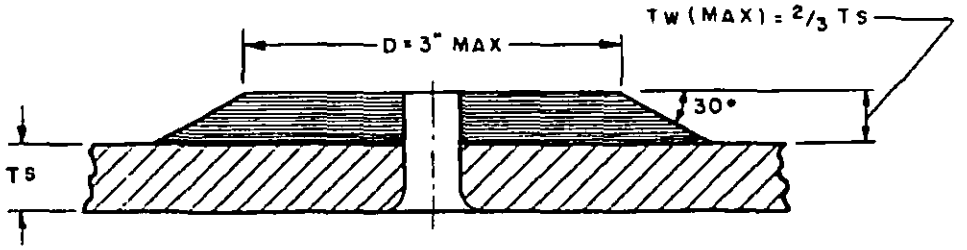
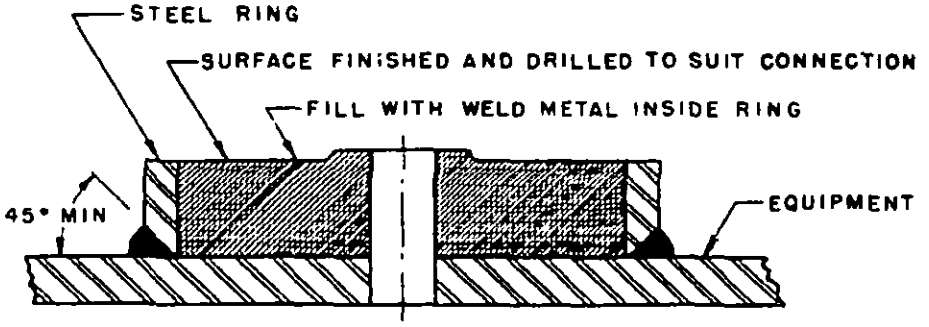
V-14



V-15



BUILT UP FLANGE PAD FOR FERROUS EQUIPMENT

FIGURE 67. Flange pads, V-14 and V-15.

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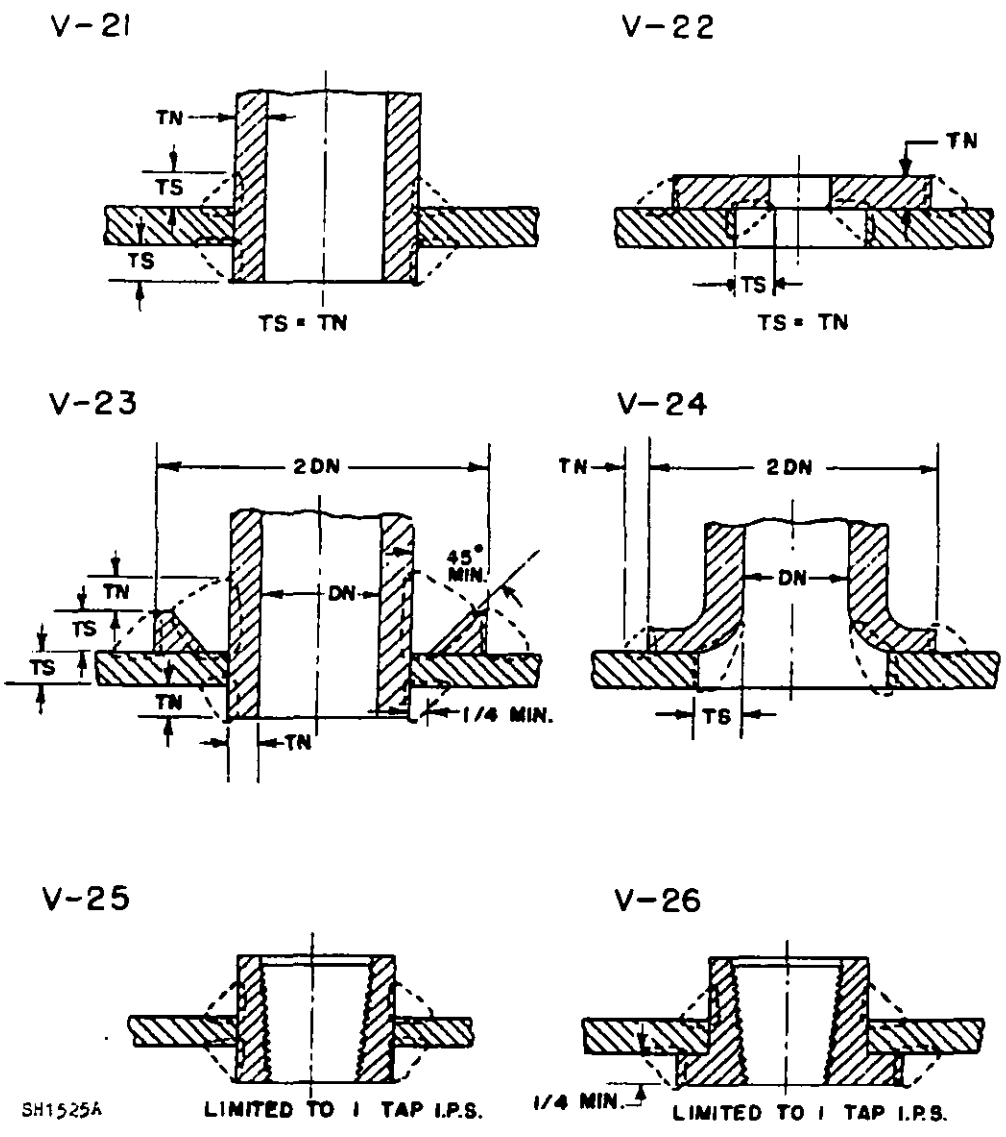

FIGURE 68. Root connections, V-21 through V-26.

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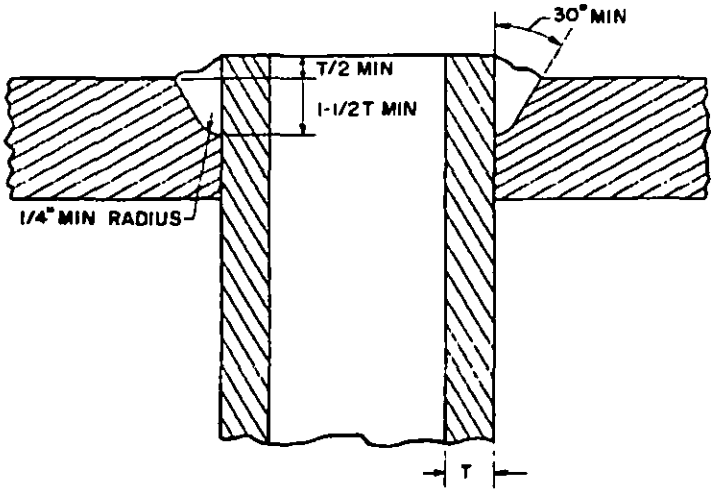
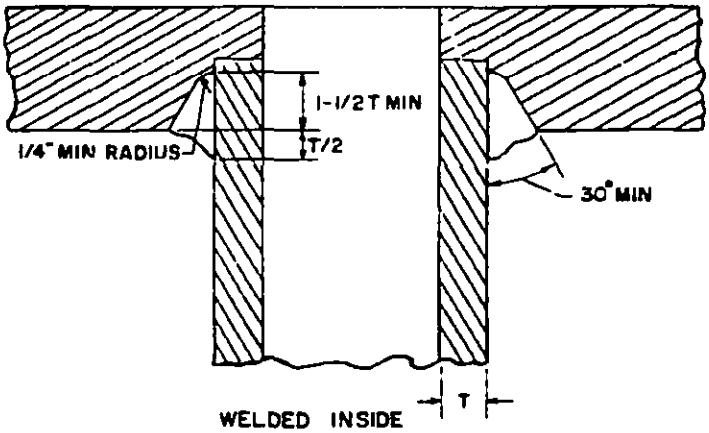
V-27



WELDED OUTSIDE

V-27



Sh1528

WELDED INSIDE

FIGURE 69. Outlet connection, fillet-reinforced single-J, V-27.

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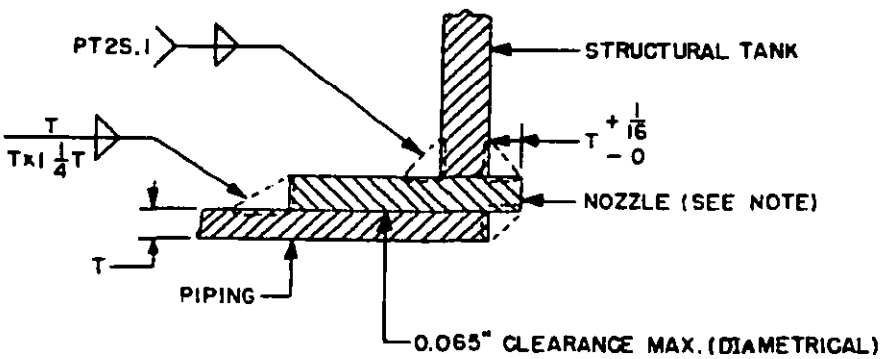
V-28



SH 9705

Note: The design of the nozzle shall be as specified on the applicable nozzle drawing.

FIGURE 70. Structural tank nozzle to pipe, fillet welded, V-28.

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a. Paragraph Number and Wording:

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